ELECTRICAL ENGINEERING

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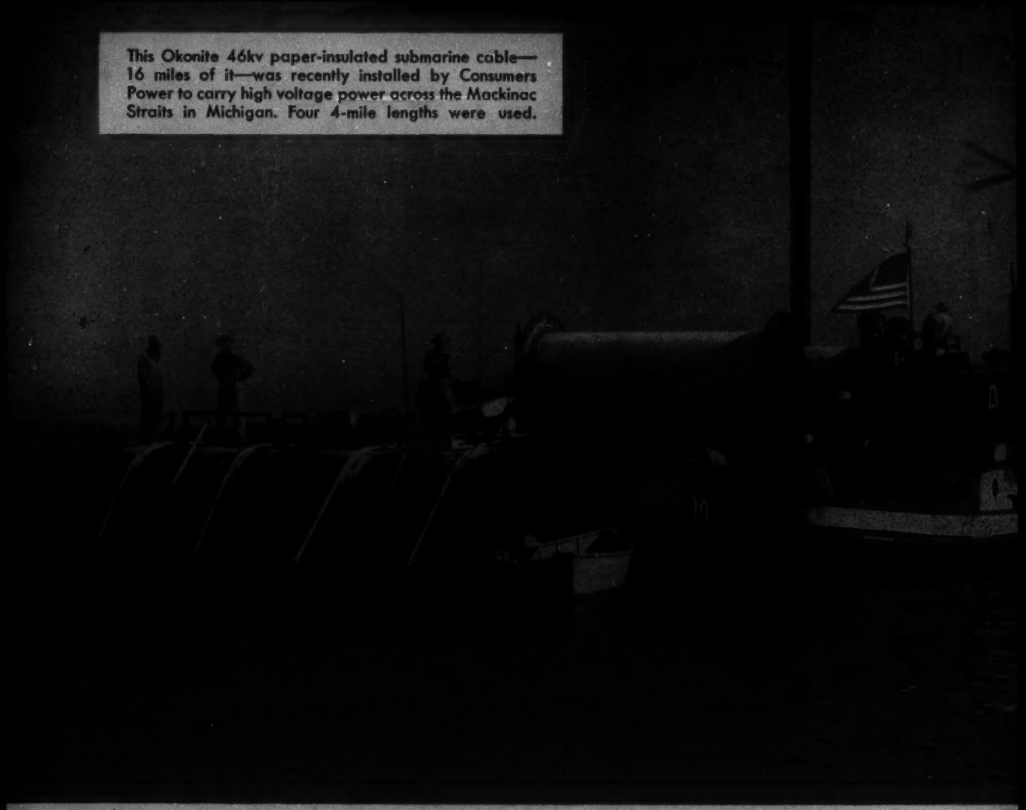

This Okonite 46kv paper-insulated submarine cable—16 miles of it—was recently installed by Consumers Power to carry high voltage power across the Mackinac Straits in Michigan. Four 4-mile lengths were used.

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STEELS FOR THE ELECTRONIC AGE

ENGINEERING PROGRESS—1956

Reviewed by AIEE Technical Committees

ENGINEERING DEVELOPMENTS during 1956 have been numerous and significant. Many of these have been reported by various committees within the six AIEE Technical Divisions.

In the field of communication an 11,000-mc microwave system is capable of transmitting television signals over distances up to 250 miles. Important advances have also been made in color television and facsimile transmission.

In the category of general applications, significant advances include the development of materials capable of withstanding extremely high temperatures and high levels of nuclear radiation.

Developments in industry include a process for high-frequency resistance welding of dissimilar metals, as well as the use of the strain gauge as a pressure pickup to obtain an electrical impulse for remote pressure indication.

In instrumentation, the trend has been toward simplicity of operation, with the emphasis on digital data presentation. A new technique has been developed for rapid, accurate measurement of low values of resistance by means of a servo ratio indicator and amplifier. Considerable research has been conducted in the field of nuclear instrumentation.

Extensive expansion of power plant facilities has taken place during 1956. In the carrier-current and relay field, increased utilization of transistors has been the trend. Numerous developments have been announced in rotating machinery, switchgear, transformers, and substations.

In the field of science and electronics, perhaps the most important single event was the activation of the first subsector in the SAGE program. Outstanding developments were also made in the fields of dielectrics, nucleonics, magnetic amplifiers, and semiconductors.

Communication

COMMUNICATION THEORY

THE PAST YEAR has seen several important developments in communication theory. A study of a class of binary signaling alphabets has unified much of the binary coding theory in addition to presenting new results. Introduction of the concept of "zero error capacity" of a communication channel has given new insight into information theory. Another such contribution is an analysis of betting with unreliable "tips," which leads to a new interpretation of information rate. Research on the problem of building reliable devices from less reliable relays was reported. First results in another important new area, communication channels with feedback, have been announced.

The continued keen interest in applications is apparent in the many papers relating communication theory and such topics as radar, television, the structure of language, and the human sensory system.

RADIO COMMUNICATIONS SYSTEMS

A NEW 11,000-mc microwave system has been developed for transmitting television or frequency multiplex telephone signals over distances up to 250 miles. The development of a new dual space diversity single side-band receiver and 20-kw linear single side-band transmitter will provide improved long distance multichannel tone telegraph, telephone, and radiophoto services. These new equipments utilize the latest type components for maximum service reliability and minimum space requirements. A newly developed time-division multiplex automatic collation terminal provides automatic repetition of out-of-balance signals in order to avoid errors in the reception of radiotelegraph messages. This equipment, termed *ARQ*, employs a combination of magnetic core and vacuum tube circuitry constructed in printed circuit form.

One of the outstanding radio engineering accomplishments has been the installation of vhf radio links to cover distances of 100 to 1,500 miles, which employ the tropospheric and ionospheric "forward scatter" principle of propagation. Although most of such installations initially have been for the military services, a large number of similar links for commercial radio communications have been planned. Very large antennas, some as much as 60 feet in diameter, and transmitter powers upward of 40 kw are used for this purpose.

Several new radio systems and components were made

The handling of telegraph messages moves one step nearer to full automation in Western Union's "private wire" networks.

Control tape editor unit for General Electric's automatic program control system.

available during the year. An airborne radio teleprinter system designated NARCAST provides printed data and information to pilots while in flight. An integrated "VOR-TACAN" system termed VORTAC makes possible the extension of the military direction finding and distance measuring system (TACAN) to civilian aviation.

New components for use in radio communication equipments included several newly developed types of germanium and silicon rectifiers and transistors.

TELEGRAPH SYSTEMS

PROGRESS IN TELEGRAPH SYSTEMS engineering during 1956 reflected an increased interest in higher speeds, greater transmission accuracy, and the integration of communications systems into data-processing procedures.

Several error-detecting and error-correcting methods were developed for use in data transmission.

The first telegraph switching system designed specifically for integrated data processing was developed by the Western Union Telegraph Company for the Sylvania Electric Company. Western Union also designed a high-speed fully automatic switching system for brokerage firms.

Use of transistors and other solid-state devices in telegraph apparatus became more common. For example, two transistorized multiplex systems were developed during the year. Electronic distributors replaced the older mechanical distributors in several equipment units.

Facsimile equipment developed by the Times Facsimile Corporation was used to transmit a special edition of the New York Times to San Francisco daily during the Republican National Convention. The transmission speed was one newspaper page in 2 minutes with a definition of 200 lines per inch.

TELEVISION AND AURAL BROADCASTING SYSTEMS

BY LATE 1956, 490 television stations (394 vhf and 96 uhf) were on the air, an increase of 35 over the previous year. The Federal Communications Commission (FCC) has now authorized television translator stations, using the upper 14 channels in the uhf band (channels 70-83, 806-890 mc). These stations, located at high points for best reception of signals from distant television stations, convert the received signal without demodulation to the uhf channel desired. With 10 watts power and a directional antenna, good reception can be provided to shadowed areas.

Although television as a whole was thriving, 10 fewer uhf stations were in operation. Some of the problems are technical, and the FCC urged that a "crash" research program be started. Late 1956 saw this development under way, and the Television Allocations Study Organization (TASO) was established. Representing broadcasting and manufacturing interests, TASO will study uhf transmission, propagation, and reception problems and report to the FCC.

Highlighting color television was the marketing of $500 receivers, using the shadow-mask tube. Several other types of color television tubes were under active development. The fall season of 1956 saw a large upsurge of color programming.

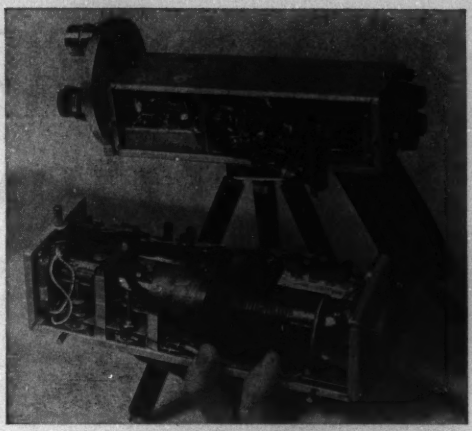
A video tape recorder and reproducer was introduced, using 2-inch magnetic tape at a speed of 15 inches per second and a rotating narrow multiple head that scans the tape transversely. Sound is recorded along one side in the usual manner. New equipment became available for automation of television operations, employing 8-channel punched paper tape for controlling seven program sources.

Educational television, first authorized by the FCC in 1952, continued to grow, and the 24 stations on the air serve a total area that includes one fourth of the nation's population. Eight more stations are expected to be on the air by early 1957. Closed-circuit television is being used by about 100 educational institutions for a wide variety of instructional uses. For example, courses in electrical engineering employ closed-circuit television at the Case Institute of Technology, Cleveland, Ohio, and mobile television cameras and receivers may readily be connected in the classrooms and laboratories desired. In Hagerstown, Md., the Washington County Board of Education started a 5-year test project to explore closed-circuit television fully for elementary and secondary school use. Six elementary schools and two high schools were connected initially, and all 47 schools in the county will be connected within three years. Equipment for the project is being furnished by the Radio-Electronics-Television Manufacturers Association, and the project is being supported further by a grant from the Fund for the Advancement of Education.

WIRE COMMUNICATION SYSTEMS

TELEPHONE SERVICE to rural subscribers has been largely provided at voice frequencies by open wire and cable facilities. Because of the distances between subscribers, and from the central office, such service has been expensive to the point where large rural areas have not been developed for telephone service. Early attempts to employ carrier over subscriber distribution circuits were made, but this method has been used only to a limited extent. Within the past year, several new types of carrier systems have been developed for operation over telephone facilities to use the rural telephone plant more efficiently and to provide service to additional customers.

Carrier systems employing both vacuum tubes and transistors are now going into the telephone plant both in the Bell System and in independent telephone territory. These systems employ miniature components and in some cases printed-wiring techniques have been incorporated. The use of transistors has appreciably reduced the power required and results in smaller, more compact units. Terminals and repeaters are located at remote unattended points and, in some cases, have self-contained power supplies for standby in case of a-c power failure. New methods of operation and maintenance have been developed which consist of simple tests at remote locations, the replacement of units in trouble, and servicing of these units at maintenance centers serving large areas. Such systems probably constitute the first large-scale use of transistors in nonmilitary installations.



The RCA developmental transistorized television camera, shown here with external case removed, is designed for spot news coverage and other television field pickup functions.

General Applications

AIR TRANSPORTATION

THE EVER-INCREASING NEED for high-performance aircraft and missiles has brought about critical needs for high-temperature materials. The degree of success in developing these materials will determine the success of modern weapons systems. The application of nuclear power to propulsion systems or to the supply of accessory power complicates the problem by making necessary operation at both high temperature and high levels of nuclear radiation.

During the past year, the General Electric Company has announced a program for developing the materials needed for operation at temperatures of about 500 C while being subjected to levels of nuclear radiation of about 10^{12} thermal neutrons per square centimeter per second. A number of materials have been developed along with techniques for their utilization. Extensive evaluations have been made to verify the capabilities of these materials.

The proven materials have been applied to the development of electrical components. Resistors, capacitors, and wire have been fabricated and operated at temperatures of 500 C and above.

These components have been used in developing transformers, inductors, motors, and electronic circuitry. These have been operated for long periods at temperatures of 500 C and higher. A number of these equipments have been operated while being subjected to both high temperature and nuclear radiation.

MARINE TRANSPORTATION

DURING 1956, the first ships built to U.S. requirements using mineral insulated metal sheathed cable (Type *MI*) went into service. These vessels are tankers built in Belgium for the Atlantic Refining Company. While these vessels were not built in the United States, they were designed and constructed in accordance with AIEE, American Bureau of Shipping, and U. S. Coast Guard requirements, and they are the first vessels in the world employing this type of cable for all purposes—power, lighting, intercommunication, and navigational aids.

Operating experience with the cable installation on these ships has been excellent, and it appears that the ability of this type of cable to withstand high temperatures and adverse environmental conditions makes it particularly suitable for marine applications. The AIEE Committee on Marine Transportation has recognized the suitability of this cable for marine applications and has added descriptive data, application information, and dimensional data to its 1955 issue of "Recommended Practice for Electric Installations on Shipboard" (AIEE Standard No. 45).

The use of aluminum switchgear aboard ships has been growing rapidly, particularly on naval vessels, where weight is of great importance. It appears that the over-all weight saving on the complete switchgear of a large vessel would range from 25 to 35 per cent and on a large aircraft carrier would amount to about 60 tons. Technical difficulties involved in its use in major current-carrying parts for marine service have been largely overcome and it is expected that more widespread usage will develop both in naval and in merchant marine applications.

In this respect, it is interesting and important to note that investigations made to determine the relative availability of steel, copper, and aluminum as applied to switchgear under total mobilization conditions indicated a much more favorable situation for aluminum switchgear than for equipment employing conventional arrangements of copper and steel.

PRODUCTION AND APPLICATION OF LIGHT

PROGRESS in the field of illumination has surged onward and upward since the development of Edison's carbon filament lamp. The Illuminating Engineering Society

(*Continued on page 22*)

ENGINEERING DEVELOPMENTS

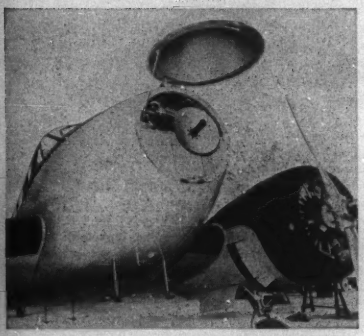
U. S. Army Photographs

▲ C. E. Sharp, Army Signal Corps Engineer, photographs radar scope, the first step in new radar technique for making a propagation map. This technique cuts time of TV, radio, and telephone microwave surveys from months to minutes. (*Top left*) This is a view of New York harbor on an Army Signal Corps radar scope located at Sandy Hook, N.J. The white spot at the top (A) is the Empire State Building and the high ground is central Manhattan. The large white area in the upper left (B) is Staten Island. The inner circle has a radius of 10 miles. Figures on the outer circle indicate direction: 0 is North; 90, East; 180, South; and 270, West. All areas shown in white have good "line of sight" reception from the radar. (*Left*) Placed on a map of New York Harbor the radar photograph shows that such points as the Empire State Building (dark spot, extreme top right) and Staten Island (upper left) would have good "light of sight" TV or radio communications with Sandy Hook. The circle surrounding the photographing radar set at Sandy Hook has a radius of 10 miles. Vertical line indicates North.

◀ Missile Master, a complete electronic system for the control and co-ordination of Nike guided missile firing batteries and other advanced Army weapons, has been developed by the Army Signal Corps in co-operation with the Glenn L. Martin Company as principal contractor, aided by the Airborne Instruments Laboratory and the American Machine & Foundry Company. Electronic consoles, similar to these radar entry consoles in the system at Fort George G. Meade, Md., are the heart of the Missile Master system. Each Missile Master operator has a display console of some form. Target information appearing on the consoles of tracking operators is displayed with distinctively shaped markers to indicate different categories of targets. Here, operators use photoelectric light guns placed against the screens to enter targets into the electronic tracking system.

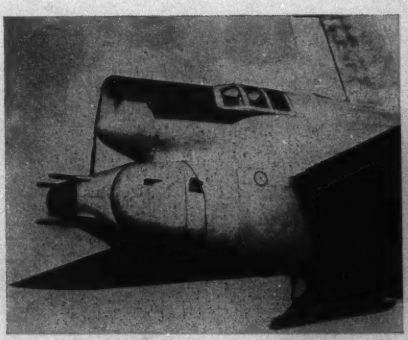
A Photographic Record of Important Electrical Engineering Achievements of the Year

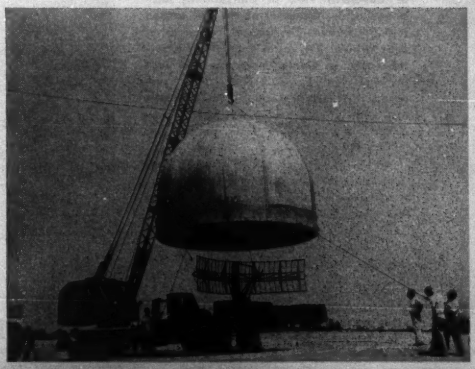
1956



▲ A 50-pound, 50-mile early-warning weather-avoidance radar system (AVQ-50) has been developed by the Radio Corporation of America to meet the "flyweight" requirements of business and private aircraft. Radar system's antenna (above) is shown installed in nose of twin-engine business aircraft. Picture of storm formations picked up by antenna is projected on a radarscope mounted in plane's cabin. RCA plans to begin commercial production of AVQ-50 radar system later this year.

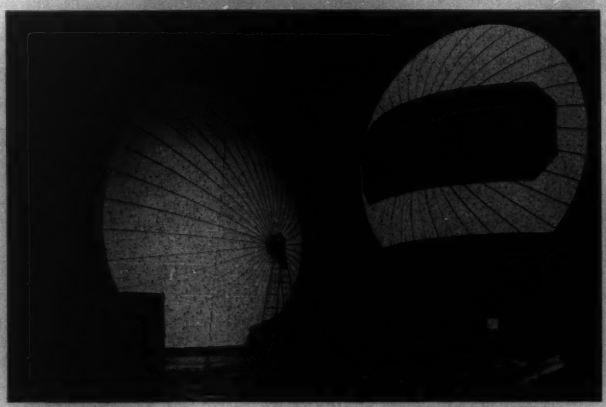
► New type radar, built by the General Electric Company, is a major factor in the high effectiveness of this tail defensive system for the B-52 "Stratofortress" bomber. Shown in close-up view are rear gunner's windows, optical sighting system, search and track radar equipment, and the gun system.

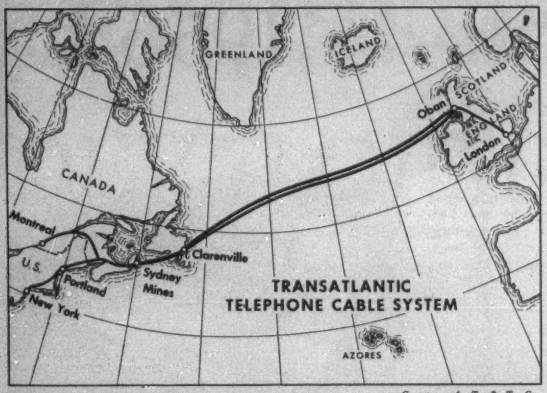




► An ordinary crane fits into the electronics picture at ARDC's Rome Air Development Center. The crane is used to lift a rigid radome over a radar antenna for the purpose of taking transmission pattern measurements. Tests were conducted at Newport Antenna Proving Range, Newport, N.Y.

► High gain is synonymous with large reflector size. The paraballoon antenna (*right*) contains an aluminum reflector that is 30 feet long and 20 feet wide. The air-inflated unit (*left*), now under construction at the Westinghouse Electronics Division, will have a reflector surface 50 feet long by 40 feet wide. The larger reflectors will give a greater degree of tactical air defense for front line troops and emplacements.



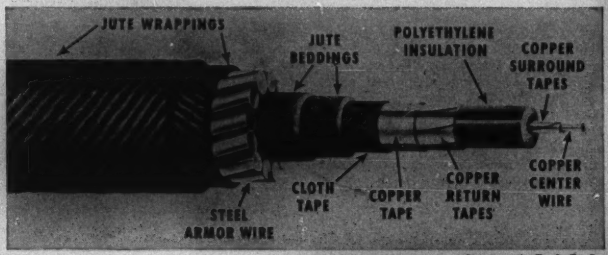


Courtesy A. T. & T. Co.

▲ The transatlantic telephone cable stretches 3,205 miles from Portland, Me., to Oban, Scotland. The 2,250 miles from Clarenville to Oban, are spanned by twin repeatered cables. A single repeatered cable extends from Clarenville to Sydney Mines, Nova Scotia, a distance of 380 miles. The 575 miles from Sydney Mines to Portland are covered by radio relay.

Courtesy Bakelite Company

▲ *HMS Monarch* which layed the North Atlantic cable. The $40 million dual telephone line runs between Oban, Scotland and Clarenville, Newfoundland. Bakelite polyethylene is used for the inner insulation.



Courtesy A. T. & T. Co.

► Cut-away view of transatlantic telephone cable. Diameter of the full section is 1.84 inches. The copper center wire, over which 36 voices can flow simultaneously, is slightly more than 0.1 inch in diameter. Three copper tapes surround this central conductor and plastic insulation covers the copper tapes, preventing any moisture from seeping in. Next come six copper return tapes, which complete electric circuit. A thinner copper tape follows that prevents underwater worms called teredos from boring into the cable. Impregnated cloth tape, jute beddings, then galvanized steel armor wire, and still more jute complete this section of cable.

Transatlantic Telephone

▲ At the Bell Telephone Laboratories, carefully selected vacuum tubes were tested for 5,000 hours at full voltage before being approved for use in the new transatlantic telephone cable system.

Courtesy Bakelite Company

▲ One of the most significant developments in communications since World War II has been the revival in submarine cable building. Since 1950, the Simplex Wire and Cable Company alone has produced more than 4,000 miles of submarine cable insulated with Bakelite polyethylene. Cable is 1¼ inches in diameter and weighs 6,000 lbs. per nautical mile.

Communications

▲ Airborne radio-teleprinter that provides continuous weather information to planes flying the North Atlantic has been developed by IT&T. Approved for use by eight transatlantic airlines, NARCAST will free voice channels, now used for weather data 80 per cent of the time, for vital traffic information. Shown with printer are the receiver and loop antenna. (*Right*) The U. S. Army now has a hand-held camera and back-carried transmitter with built-in power supply. Soldier-scouts, unhampered by cumbersome cable connections, can now reach previously inaccessible spots. Push-button controls in jeep console provide monitoring view of pictures from five cameramen in the field.

Courtesy U. S. Navy

▲ J. T. Mengel, Project Vanguard scientist, examines Minitrack transmitter pack and an exhibition model constructed in clear plastic so that components are clearly visible after assembly. The real transmitter, which Mr. Mengel is holding in his hand, is assembled in a gold-plated aluminum container.

Courtesy Bell Telephone Labs.

▲ The telephone set displayed here contains a musical tone device that may someday replace the telephone bell. Tone radiates through louvres at base of set. Tests show tone stands out above general room noise, and is an aid to the partially deaf because the musical tone contains more energy in the middle frequencies where hearing acuity is greatest.

Courtesy U. S. Army Signal Corps

▲ U. S. Army Signal Corps' latest long-range radio transmitter-receiver for jeeps, tanks, and trucks. Easy to use with seven preset channels, the set can be operated moments after an air-drop. Extremely wide frequency range and great power relay messages over mountains or other barriers without relay devices.

Courtesy Philco Corporation

◀ A Philco engineer pans the camera of an airborne TV system developed recently for the Navy's Bureau of Ships. Camera pickup is being transmitted to receiving location 50 miles distant. Systems of this type could be used for control of amphibious landings. (*Right*) Twenty-eight foot parabolic antenna at Dorado, Puerto Rico, developed by IT&T, is the terminus of the 238-mile microwave link between Puerto Rico and the Dominican Republic. Path losses in this area are 15 db less than those in northern U. S. A 500-watt transmitter is housed in building at the right.

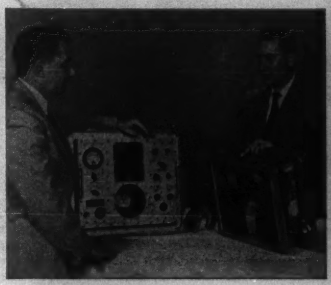
Instrumentation

Courtesy General Electric Co.

▲ New transistorized alpha radiation detection instrument (*left*) developed at Hanford by GE. Survey meter is smaller, lighter, more rugged, and less sensitive to temperature and humidity changes than older instrument (*right*).

▲ For more than two years at Miami, Fla., General Motors research staff has made a continuous record of intensity of sunlight in various parts of the spectrum by means of a spectroheliometer or Sunshine Spectrum Recorder. The record is correlated with the weathering of automotive finishes visible on exposure racks in background.

◀ Impact Noise Analyzer, Type *1556-A*, has been developed by General Radio Company as an accessory to a sound-level meter. Certain significant characteristics of impact noise can now be analyzed. To industry, certain impact noises are a serious problem because of possible hearing loss. Impact noise from a punch press is being analyzed by means of analyzer and sound-level meter.



► Test sets so rugged they can function after being dropped 30 inches onto concrete or immersed in water are displayed at the U.S. Naval Ordnance Laboratory, White Oak, Md. Panel (*left*) and chassis (*right*) are housed in fiber glass case.

◀ Robot with x-ray eyes, built by GE for the Army Ordnance Corps, automatically inspects the explosive charge in each artillery rocket coming off the production line. Machine inspection eliminates "human error," saves large sums of money, and relieves shortage of x-ray technicians.

► Control unit of Federal's Autopilot can fit either on control pedestal of a plane or on instrument panel in much the same way as a car radio. Control unit consists of manual "turn" control, "pitch" control, manual "course" trim control, and two on–off "roll" and "pitch" switches.

Courtesy Federal Telephone and Radio Co.

Courtesy Federal Telephone and Radio Co.

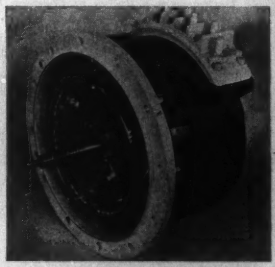
▲ **Autopilot System, F200, for mediumweight, private and business aircraft, weighs only 17 lbs and is no bigger than a typewriter. It contains a gyro–servo assembly (top), control panel (lower left) and a turn-bank indicator. Federal's F200 sells for $1,995.**

Courtesy International Business Machines Corp.

▲ **IBM's electric typewriter with electronic tabulation speeds preparation of business forms containing blank fill-in areas. The electronic "reading" feature eliminates tabulating adjustment when using a variety of forms. Vertical lines printed on the form with conductive ink program carriage to stop at correct typing point.**

◄ **B. Kazin, RCA Laboratories, demonstrates electronic amplifying fluoroscope capable of increasing by 100 times the brightness of x-ray images for direct viewing. Display box compares new amplifying screen (left) and conventional type (right). X-ray image of the electron tube appears brightly only on the amplifying fluoroscope.**

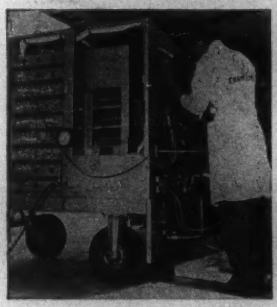
► **This generator will deliver its full-rated output independent of aircraft speeds, ambients, and altitudes. Generators of the J&H oil-cooled family, ranging from 2.5 kw through 40 kva, were developed to meet power needs of aircraft such as the F102 and missiles of the Bomarc and Navaho type.**



Courtesy Jack & Heintz Inc.

◄ **Electrofax, automatic dry-photographic enlarger-printer which can enlarge, develop, and print 15 standard size engineering drawings from microfilm originals within one minute. Equipment can be used with Filmsort filing process which utilizes individual microfilm exposures of drawings mounted on separate business machine cards. H. G. Reuter, Jr., RCA engineer, inserts stack of cards in unit. Up to 500 cards can be handled at rate of one every four seconds.**

Courtesy Radio Corporation of America



Courtesy American Machine & Foundry Co.

▲ **In AMF's Turbo Division, mobile mount is used to test accessory power supplies for guided missiles. Fuel and sensing instruments remain on cart during test to minimize installation and removal time. Pickups on the power supply are being connected to recording instruments on the permanent console in the test cell.**

Rotating Machinery

Courtesy Westinghouse Corp.

▲ The four Westinghouse 217,260-kw turbine-generators at the Ohio Valley Electric Corp.'s station at Cheshire, Ohio, are designed for steam conditions of 2,000 psig, 1,050 F initial, and 1,050 F reheat temperature. Each turbine-generator is a high-pressure, cross-compound, hydrogen-cooled, reheat unit. The high-pressure element drives a 130,000-kw, 3,600-rpm, 85 per cent pf generator. The low pressure element is of the double flow type and drives an 87,260-kw, 1,800-rpm, 85 per cent pf generator.

Courtesy General Electric

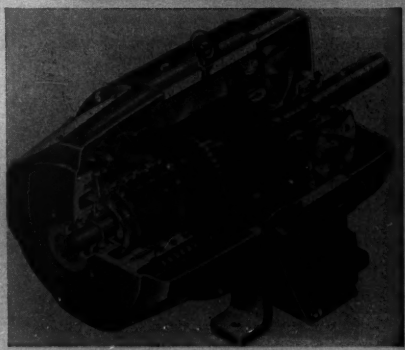
▲ A 150-ton capacity overhead crane manipulates 42,000 lb generator rotor being inserted in a steam turbine-generator unit destined for Caracas, Venezuela. Electricity from unit will operate pumps to lift water from the River Tuy to an artificial lake whence it will flow to the city.

Courtesy General Electric Co.

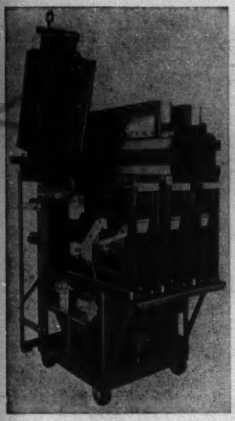
◀ The steam turbine casing enclosing the pressure section of the world's first commercial supercritical pressure steam turbine-generator unit. Turbine's initial steam pressure will be 2.25 tons per square inch at initial temperature of 1,150 F. It is rated at 125,000 kw, enough for a city of 208,000 persons. (*Right*) This 40-ft. boring mill has been operating around-the-clock seven days a week machining a 150-ton section of the world's first 300,000-kw steam turbine-generator unit for Detroit Edison's River Rouge station.

Courtesy Allis-Chalmers

◀ Turbine-generator's 76-ton, 4-pole, 1,800-rpm rotor (*lower right*) and its 35-ton, 2-pole, 3,600-rpm partner suspended from crane are shown during manufacture at Allis-Chalmers. (*Right*) GE's Kinamatic motors have exciting and commutating field coils (A and B) insulated with mica and glass; (C) brush rigging, with bronze brush holders.



Courtesy General Electric



◀ I-T-E Circuit Breaker Co.'s new power circuit breakers meet three new standard ratings for metal-clad switchgear. For 13.8 kv, 1,200 and 2,000 ampere applications, new *15HV-750* units (illustrated) have interrupting rating of 750 mva. Additions to the 4.16 kv line are the *5HV-350* breakers which have a continuous current rating of 3,000 amperes for main and bus ties or 1,200 amperes for feeders. Also for 4.16 kv, 1,200 ampere applications are the *5HV-75* with higher interrupting rating of 75 mva.

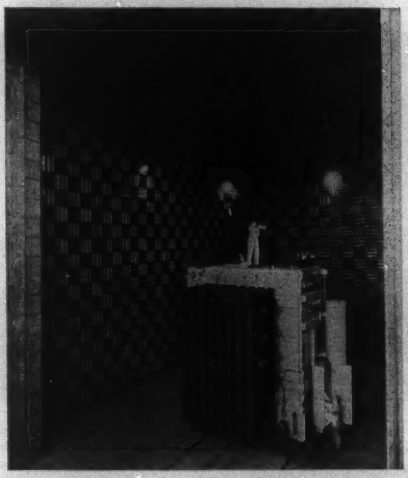
Courtesy Westinghouse Co.

▲ Three-unit cascade transformer bank in the Westinghouse Transformer Division's test center, Sharon, Pa., supplies 1.05 million volts at 60 cycles for development and commercial tests. Metal doughnuts at base of tallest unit effectively increase distance between tank and ground by reducing the high surface voltage gradients. 150-ton door of anechoic vault can be seen in background.

TRANSFORMERS

▲ Gas-filled power transformer, believed to be the world's first, is inspected before shipment from the General Electric plant, Pittsfield, Mass., by Guglielmo Camilli (*center*), leader of the scientists and engineers who developed the revolutionary new design, and E. S. Martin (*right*), project engineer. The unit is the first of two transformers for Consolidated Edison Company of New York City.

Courtesy General Electric Co.

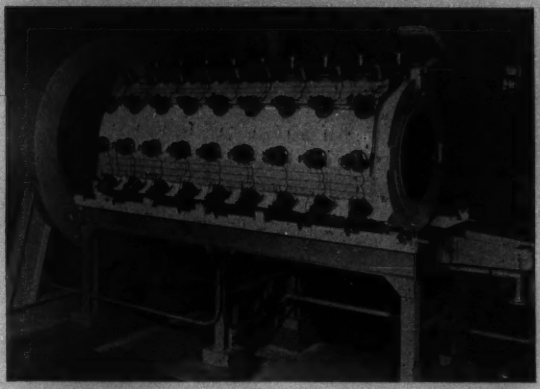


▲ Westinghouse's anechoic vault where complete sound measurements on transformers rated more than 500,000 kva and weighing more than 400 tons are made. Vault is primarily a research and development tool to aid in designing transformers that are quieter and more efficient, yet smaller and lighter. Designed for an ambient noise level of less than 30 db, it has walls nearly five-feet thick. A solid layer of steel lining the inner wall of the structure shields the room to permit radio-influence measurements on large units. (*Left*) Mobile 7,500-kva substation, built by GE for the Illinois Power Company, can supply enough power for community of 15,000 persons. Utility will use it to maintain service when regular stations are shut down for maintenance.

Reactors

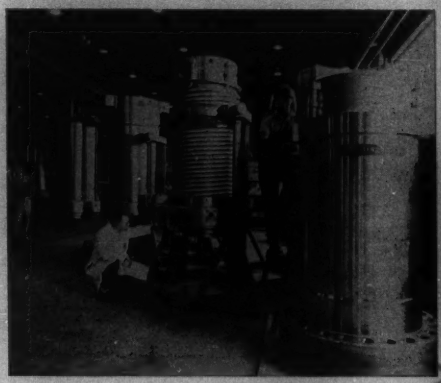
Courtesy General Electric Co.

▲ D. R. Shoults, general manager of GE's Aircraft Propulsion Department, holds electronic assembly used in history's first successful long-range operation of electronic components for atomic reactors. Components were subjected to 90 per cent of maximum reactor radiation and to temperatures ranging up to 450 C (842 F).

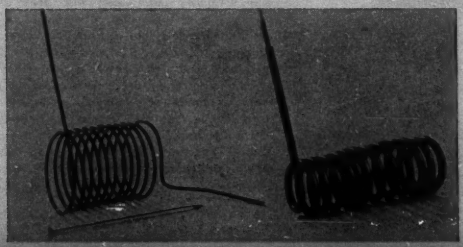


▲ Los Alamos human counter scintillation tank with 108 photomultiplier tubes outside its 20-ton shield.

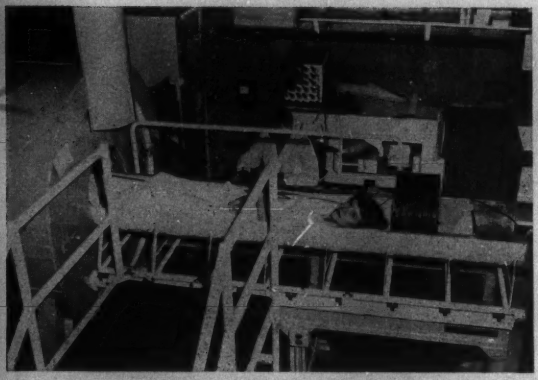
▲ Small-size plant developed by GE engineers at the Hanford atomic plant duplicates most of facilities of actual plant for separating plutonium from uranium. The prototype tests chemical methods of separating plutonium from uranium that has been irradiated inside an atomic reactor. Process steps are controlled outside.



▲ These four 1,600-hp, 2,300-volt, "canned" motor pumps are in final stages of construction at the Westinghouse Atomic Equipment Plant, Cheswick, Pa. They are the main coolant pumps for the nation's first full-scale atomic electric generating station at Shippingport, Pa. Each pump weighs nearly 14 tons, stands 10 feet high and is 4 feet in diameter. Capacity of each pump is 18,300 gpm at 2,000 psi at up to 6,000 F.



◀ General Electric's concentric thermocouple, smaller than a straight pin, combines durability, flexibility, and small size, making it suitable for reactor temperature measurements.



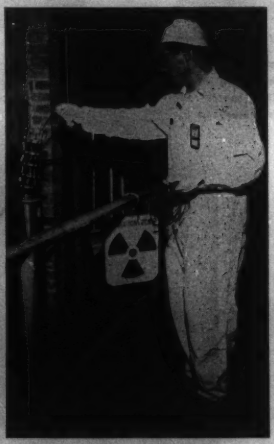
▲ The Los Alamos human counter for *in vivo* gamma measurements at very low levels with 4π liquid scintillation detectors.

Courtesy Westinghouse Corp.

▲ Mechanical liquid-metal pump built by the Westinghouse atomic equipment department can operate at temperatures up to 1,600 F. Available in ratings up to 5,000 gpm, it will be used in nuclear power plants, chemical process lines and other applications requiring high-temperature heat transfer mediums.

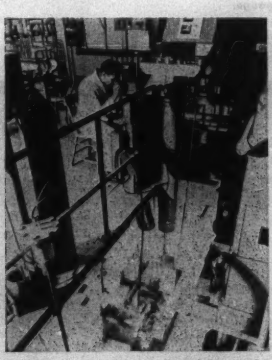
Courtesy General Electric Co.

▲ GE's robot chemical analyzer recovers plutonium valued at $250,000 a year. Dimples in tape contain samples of liquid waste from plutonium refinery. Radiation detector determines presence of plutonium.



Courtesy General Electric Co.

▲ Rubber strips inside a metal basket being lowered down a metal tube surrounded at the bottom by radioactive uranium. Test shows how materials stand up to gamma radiation.



Courtesy General Electric Co.

▲ An aerial type camera is used by GE employee to take underwater photos of intensely radioactive uranium fuel.

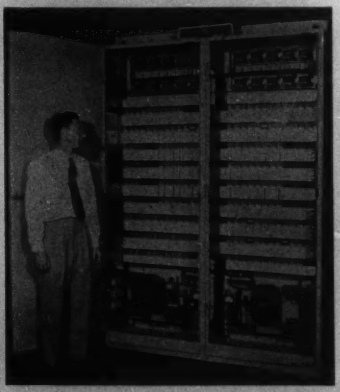
► Sodium iodide crystal "eye" in watertight, windowless aluminum container (*left*) affords a better "view" into test wells containing radioactive wastes at the Hanford atomic plant operated by General Electric. (*Left*) Closed circuit color TV helps operate giant overhead crane in radioactive area of Hanford plant. TV system gives added depth perception and high image brilliance during operation of crane.

Automation

Courtesy American Machine & Foundry

▲ Automatic cigarette making machine by AMF incorporates beta gauge and dielectric bridge for precise control of long- and short-term variations in cigarette rod density. Main control cabinet *(top center)* for microfeed regulator system contains vibrating reed electrometer fed by beta gauge.

▲ "Nerve" cells for a new switch stimulate assembly-line automation. Developed by Minneapolis-Honeywell, the switch, monitoring a sequence of metal parts, "confirms" each piece as it passes and trips a remote relay that moves the part on. Conversely, it shuts down assembly line if break in parade of pieces occurs.



▲ Static switching system provides General Electric engineers with a new automation tool in the form of seven basic static control elements for use in tailor-making completely automatic control systems in applications ranging from steel mills to conveyor drives. One of the seven elements, a multipurpose unit, has a permanent memory function even on loss of power, and can serve 15 basic control functions. Control panel directs the switching and memory operations of an automatic conveyor system routing a variety of major household appliances from the main product transfer conveyor to one of several warehouse shipping areas at GE's Appliance Park in Louisville, Ky.

Courtesy General Electric Co.

▲ This 85-ton contour profile milling machine is controlled by a GE electronic tracer control system capable of making split-second "decisions." Giant machine, manufactured by Onsrud Machine Works, processes spar and wing chords and wing skins for Boeing Airplane Company. (Left) Machine cuts surface on wing cord. GE tracer control operates from lineal cams or templates mounted parallel to the working surface and located near the base of the machine. In operation, the cutting tool is guided over the work piece by tracer heads which automatically follow the contours of full-size master templates and control the speed of the feed drives.

▲ An electric entry station machine designed by Armour Research Foundation for Sears Roebuck Co. automates order handling and provides inventory statistics. The basic element of the system is a magnetically recorded file card, which contains information of catalog items in both visible and magnetic form. Equipment can produce and read magnetic cards, prepare item shipping ticket, calculate the extended price and total order amount, and produce a punched tape record of order statistics.

▲ This punched-card transcriber, developed by the National Bureau of Standards, converts numbers and instructions on cards into a serial binary code. In this form, the information can be fed either directly into an electronic computer at rates up to 600 punched cards per minute or stored on magnetic tape.

Computers

Courtesy International Business Machines Corp.

▲ IBM's electronic data processing machine, the *305 RAMAC*, is built around a disk memory unit, visible in background, having a storage capacity of 5 million digits. Unit consists of 50 magnetic metal disks arranged in a vertical stack, with data recorded on or read from each side of the disks by a rapidly moving arm. "In-line," rather than "batch," data processing made possible by *RAMAC* is expected to alter completely the course followed by business accounting for the past 50 years.

◀ Transistors are under intensive investigation at Bell Telephone Laboratories (BTL) to determine their suitability for airborne electronic computers. Current phase of investigation is the feasibility study of a large coincident-current magnetic core memory system operated entirely by transistors. E. L. Younker, BTL engineer, is testing such a system. Mr. Younker believes that experience to date indicates a transistor driven memory of this kind is entirely feasible and quite attractive. (Above) National Bureau of Standards has developed an analog computer that will help in predicting the distribution and intensity of ground radioactivity following nuclear explosions. Problem solution is displayed on cathode-ray tube over which a transparent map can be laid. Radioactive intensity at any ground point up to 200 miles from ground zero can be determined by measuring the brightness at the corresponding point on the tube screen.

◄ Dr. D. W. Lewis, Westinghouse research scientist, demonstrates heat resistant properties of a new solventless silicone resin (*left*). Lead on the hot plate melts while a conventional insulating resin (*right*) smolders, but the newly developed resin remains intact. Resin is ideal as high-temperature electrical insulation.

► Dr. M. A. Biondi, Westinghouse research physicist, uses microwaves to study the superconductivity of metal sample cooled by liquid helium to a temperature one degree above absolute zero. Purpose is to learn why certain metals, at low temperatures, permit electric currents to flow apparently forever.

◄ Test demonstrates Westinghouse Research Laboratories' NIVCO, superalloy for high-temperature steam turbine blades. NIVCO, the first practical result of research technique for "predesigning" metals of the future, will mean greater efficiency for tomorrow's electric power plants.

► A new process for producing ultrapure silicon has been developed by the Bell Telephone Laboratories. H. C. Theuerer (*left*), shown with coworker J. S. Doyle, found that boron impurities can be removed from molten silicon by reaction with water vapor. Process may result in improved semiconductor devices.

RESEARCH

Official Photograph U. S. Navy

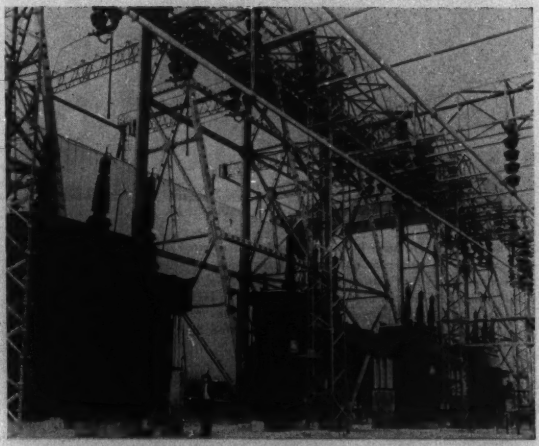
▲ View of instrumentation used in the measurement of velocity of strong shock waves in the hypersonic shock tunnel by multiple reflection microwave interferometry. Usable from velocities of Mach 6 up, the instrumentation operates on the principle of a cylindrical microwave cavity, the length of which can be changed by a conducting piston to provide resonance of the cavity at half-wave length intervals. In this application, the highly ionized shock front replaces the piston. Shock velocity can be determined within 2 percent from the oscilloscope trace of the resonance peaks.

▲ The science of solid-state electronics depends for its growth and vitality on a supply of ultrapure and ultra-perfect semiconductor crystals. Impurities and imperfections in the semiconducting crystal have been found to influence materially the behavior of transistors and other solid-state devices. K. E. Benson and A. J. Goss of Bell Telephone Laboratories have found an important relationship between the two. Mr. Benson is shown with the zone-melting apparatus employed in growing single crystals of germanium-silicon alloys.

Wind Tunnel

Official Photograph, U. S. Navy

▲ The pressure ratio recorder (above) was developed in the Naval Ordnance Laboratory's Aeroballistic Research Department for use with a synchro-controlled probe mount. The recorder performs rapid and highly accurate, continuous pressure surveys of the air flow through the wind tunnel nozzle. It records the ratio of measured pressure to supply pressure so that these ratios are available by the conclusion of the test. A complete flow field survey at any given Mach number (some 100 pressure ratio recordings) can be made within one hour, including the time for probe installation.



Courtesy Arnold Engineering Development Center

▲ Transformer yard of the Propulsion Wind Tunnel Facility showing two 66,000 kva transformers at ends of yard and two 37,500 kva transformers for the four main drive motors. The 66,000 kva transformers serve the two 83,000 hp motors; the 37,500 kva transformers serve the two 25,000 hp motors.

► View of the transonic control room of the propulsion wind tunnel. Left-hand panel controls the flexible nozzle, stabilizer, test section, and diffuser. The center panel contains instruments for information during tests, power consumption control to the main motors in the motor drive building, the compressor, and the make-up air flaps. Right-hand panel controls scavenging scoop, valves, and cooler No. 1.

Courtesy Arnold Engineering Development Center

Courtesy Arnold Engineering Development Center

◄ Arrangement of four motors, totaling 216,000 hp, that are to drive the compressors for the transonic and supersonic circuits of the Propulsion Wind Tunnel Facility. An 83,000 hp drive motor is located at each end of the line-up with the center positions occupied by the other two 25,000 hp starting motors. Arrangement is such that the motors may be used with 108 hp on each circuit or 216,000 hp on either of the two circuits.

TRANSISTORS

▲ Photo transistors have been harnessed by Western Electric to read meters automatically. Photo transistor and its light source, a switchboard lamp, are mounted on a double arm that can easily be attached to the outer case of any meter (*upper right*) and set to any desired reading. Test set is for telephone set varistors. When meter needle, moving between the photo transistor and the light source, breaks the light beam, varistor is either "okayed" or rejected by energized circuit.

Courtesy Radio Corporation of America

▲ View of RCA's all-transistor, marker-beacon aircraft receiver which operates on less power than a flashlight; weighs 15 ounces, and is 2 x 4 x 5 inches.

▲ Subminiature *M-1* transistor is believed to be the smallest Philco transistor yet developed. It operates in the audio frequency range and performs the functions of larger transistors. The M-1 can be used in electronic systems, such as guided missiles, computers, hearing aids, portable radios, and equipment where miniaturization is an important factor. The device withstands an acceleration rate of 20,000 "G's" without change in characteristics.

► First completely transistorized power line carrier assemblies are shown installed at the Potomac Edison Co., Hagerstown, Md. Instead of steel cabinet (*lower left*) with interconnecting wiring to relay switchboard, all new equipment is contained in a Flexi-test (registered) case (*right*), 22 x 6 x 6 inches. Case is then mounted directly on switchboard. Units require practically no floor space and only one cubic foot of substation space.

Courtesy Westinghouse Corp.

► Major breakthrough in transistor technology is claimed by Bell Laboratories. Key element is the development of controls over microscopic chemical layers. Technique makes possible a "base" layer 50 millionths of an inch thick. Device's performance at very high frequencies surpasses that of any other transistor. Electrical contacts are made to germanium by vaporizing a metal onto the surface of the material. Later, wire leads are attached.

Tubes

◄ F. H. Harris, scientist at Naval Research Laboratory, holds electric output charge-storage tube, which he developed. Tube differs from conventional types in that reading time can be extended to hours or even days, with no appreciable decay of stored pattern.

► Electronic tube, developed by Westinghouse, times successive flashes of light less than one billionth of a second apart. Improved type of photo-multiplier tube, it uses a "chain reaction" of electrons to strengthen and measure flight of speeding atomic particles. Dr. E. J. Sternglass adjusts radiation beamed into tube.

Courtesy A. B. DuMont Labs., Inc.

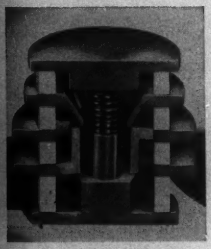
◄ Multiplier phototube, ¾-inch, 10 stage, extends range of geophysical investigations. It has rated average gain of 300,000 at 105 volts per stage. Information from tubes lowered miles into earth remains strong enough to identify accurately structure of subsurface strata.

Courtesy Radio Corporation of America

▲ L. P. Garner (*left*), RCA official, points out superpower transmitting tubes to D. Y. Smith, vice-president of RCA. Developmental tube, *A2346*, is expected to generate the highest average power of any tube yet built. Mr. Smith's hand rests on a cutaway version of the *A2335* tube, intended for UHF applications demanding power in the order of 100,000 watts. On right is the *A2332*, used by the AEC in atom-smashing accelerators. Continuous power of more than 1.5 million watts at 425 kc has been developed by this tube.

► Developmental vidicon camera tube for light-weight TV camera is the size of a king-sized cigarette. Vidicon is only ½-inch in diameter. Photo surface of tube has a substantially greater sensitivity to light than that of standard 1-inch vidicon.

Courtesy Radio Corporation of America



Courtesy General Electric Co.

▲ Voltage tunable magnetron, tuned electronically over an S-band frequency of nearly 2-to-1, is under development by GE.

► Heart of powerful shipborne radar installed on *U.S.S. Northampton* is magnetron designed by Westinghouse. "Big Maggie" delivers 10 million watts peak and can search out enemy planes 400 miles away. Complete tube weighs 60 lbs but its permanent magnet weighs 300 lbs. Cathode operates at temperatures up to 3,100 F. Magnetron operates as a sealed oscillator, employing water and mild forced-air cooling.

▲ A fluorescent lamp with double the light output of present tubes of equal length has been developed by the General Electric Co. Increased light is made possible by a series of lengthwise dents or grooves along one side of the eight-foot-long fluorescent tube. This design permits maximum circumference of the tube while constricting its inside area. The greater light output results from an increase in area of the lighted tube surface, the higher wattage at which the new tube can be operated, and the more effective use of energy within the tube.

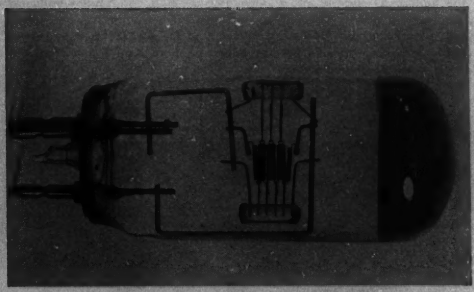
Courtesy Westinghouse Corp.

▲ World's first flashlight in which electroluminescent disc replaces bulb and reflector. Transistors step up and convert battery voltage into high-frequency alternating current. Resultant electric field causes disc to glow.

Illumination

Courtesy General Electric Co.

◀ GE's "twinkle lamp," revealed at the American Toy Fair, simulates the nighttime spectacle of countless fireflies. Fascinating effects are produced by a lamp that is the size of the smallest Christmas bulb. Self-flashing bulb comes in red, yellow, green, blue and clear glass. (*Right*) General Electric's peanut-size PowerMite (registered trade mark) M2 flashbulb has been improved in performance and versatility. Bulb has 66 per cent more light than previous M2. A new blue bulb has been developed for color photography, the M2b, rated at 5,500 lumen-seconds.



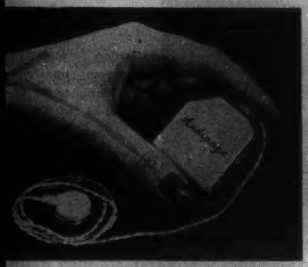
Courtesy General Electric Co.

▲ "Gold Top," a photo projection lamp developed at GE, combines horizontal burning with a vertical filament and a baseless construction. These features make possible a lamp that (1) operates at cooler temperatures, (2) is precision-focused, (3) makes low contour projector designs possible, and (4) insures cost savings in projector designed for its use. The 500-watt version shown will also be available in the 300-watt size.

Courtesy Westinghouse Corp.

▲ The 1,000 watt, semireflector, Westinghouse fluorescent mercury lamps provide improved color rendition and greater light efficiency. Lamps make golden-white mercury light practical in high bay industrial lighting applications where fully coated lamps cannot be used efficiently.

Radio



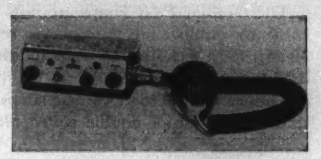
▲ "Audipage," Philco Corporation's personal receiver, is smaller than most cigarette lighters and easily hidden in a person's garments. Receiver operates on the principle of induction. It receives only within the restrictions of an audio magnetic field set up by a wire "loop" around the perimeter of an area. Audipage promises to be of use in places where conventional public address systems are impractical.

Courtesy General Electric Co.

▲ Towering vertical parts bins, moved up or down by operators with flip of switch, speed assembly of military electronic units and save floor space at GE's Light Military Electronic Equipment Department, Utica, N.Y. (*Left*) GE's all-transistor pocket radio is available with rechargeable batteries good for 10,000 hours of use. 6¾ inches long, 3½ inches high, 1⅜ inches thin, and weighing only 20 ounces including batteries, the six-transistor radio provides twice the sound volume and four times the sensitivity of previous transistor models. Earphones may be plugged into back of set for private listening.

Courtesy U. S. Signal Corps

▲ Cpl. Harry Mikus of Fort Monmouth, N.J., reports to his squad through the world's smallest combat radio, which is built into his helmet. The two-way FM set is smaller than two packs of cigarettes and weighs less than 1 pound. A single set of tiny batteries is sufficient for 12-hours continuous operation. To operate, the scout merely flips a switch to talk into a thumb-size microphone.



▲ Control head and microphone of the Du Mont model *MCA-105-B*, a mobile radio system supplying 100 watts minimum output across its entire frequency band, 25 mc to 54 mc. The control head can be mounted on or under the dashboard. The palm microphone offers superior audio response and higher output in addition to a front hang-up button.

▲ Designed especially for leadless insertion in printed wiring board circuits, General Electric's "Wejcap" capacitors are inserted either manually or by placement machines in board slots. Dip soldering then makes permanent bond to the connection point, as in this typical TV receiver subassembly. They feature low cost, small size, durability, and moisture resistance without bulky outer covers. TV receiver applications are: antenna coupling networks, automatic volume control and automatic gain control networks, screen by-pass, and other medium-tolerance circuits.

▲ General Electric's improved, long-range communications receiver is part of synchronous detection system developed for the Air Force. The system is a refinement of the basic a-m radio technique used for many years. Dr. J. P. Costas operates receiver.

celebrated its 50th Anniversary with an issue covering the history of that organization and developments of the lighting industry. The industry has come a long way since 1906 when carbon lamps were supreme while tantalum and tungsten lamps were neophytes. Lamp demand was 38 million in 1906, quite a contrast to the billion or more incandescent, mercury vapor, and fluorescent lamps of today. Lamp types were few then but are multitudinous now. The past year has seen the following developments:

The familiar incandescent lamp has become smaller as coiled-coil filaments are used in more lamps. The 3-light lamps are the latest to be designed for use in smaller envelopes. Larger wattage lamps are next on the list to be reduced in size. New medium base 100/200/300-watt *A-25* lamps and 30/200/230-watt high-low lamps were announced.

Additional warm and cool tints of colored lights have been added to the pink lamp of a year ago, with which to create varying atmospheres and moods in homes, restaurants, and similar environments. Flashing of Christmas tree bulbs operating at 6.3 volts is accomplished by means of a bimetal flasher.

The familiar *PAR* lamps are now being made in six colors for outdoor use. Also new in reflector lamps is the 30-watt *R-30* neck silvered lamp and the 1,000-watt *RB-52* double contour bulb.

The efficiency of high wattage lamps has been increased through the use of double coiled filaments and a new axial position of the filament.

Two new sealed-beam headlights were designed for use in the automotive industry's new 4-lamp headlighting system. Each pair consists of one lamp which produces only an upper beam, and one with both upper- and lower-beam filaments.

The results of constant changes and improvements in electric discharge lamps are longer lamp life and higher efficiencies. With respect to fluorescent lamps, two new

Testing high-temperature transformers designed to operate at 500 C.

Courtesy General Electric Company

8-foot, 200-watt, very high output, rapid-start lamps were announced. One of these uses a grooved 2⅛-inch diameter bulb, the other a 1½-inch diameter bulb, the latter using neon as a filling gas instead of argon. A deep-blue fluorescent lamp was made available for use with signs.

There is an ever-increasing use of mercury-vapor lamps for street lighting—4 per cent of the streets in the United States now being lighted with mercury. Several improvements have been made in color-corrected mercury lamps now used to light schools and airports. A 1,000-watt, semireflector, mercury lamp provides color improvement and adds up to 15 per cent more light on the work than conventional lamps.

Levels of illumination rising toward the 300 foot-candle mark, primarily due to automation, are demanding better light control and improved brightness ratios. Prismatic control of light using acrylic plastics have been developed for luminous ceilings as well as for individual fixtures. A new street lighting luminaire uses two banks of six fluorescent lamps each 6 feet long; a trough emitting light and air has air diffusers concealed inside; and a fixture with adjustable louvers for lighting vertical surfaces has recently been introduced. These are just a few of the many devices being fabricated to provide for a bright, comfortable, and pleasant future.

A home magnetic tape player for television is shown here with Dr. H. F. Olson, RCA Laboratories, who directed its development. It can play pre-recorded black-and-white television selections from magnetic tape through any standard television receiver.

Industry

ELECTRIC HEATING

One of the most interesting engineering developments in 1956 in the high-frequency heating field has been the development of a process for the high-frequency resistance welding of dissimilar steels and dissimilar metals, such as continuously welding a strip of high-speed steel to a strip of high-carbon steel for use in reducing the cost of industrial hack saw and band-saw blades in which the teeth are cut into the edge of the high-speed steel. High-frequency power at 450,000 cps is fed into the two strips of metal as they are brought together raising the temperature to the welding point and producing welds at speeds in excess of 100 feet per minute. The equipment compensates for the different resistivity and welding temperatures.

In the field of radiant heating, many new applications are being worked out using the new high-intensity quartz infrared lamps, both in the low temperature-high speed and the high temperature field. Product tempera-

Mineral insulated cable installed on fore and aft walkway of tanker.

tures well in excess of 1,000 F have been obtained. Typical of the latter is an installation in Canada using the quartz lamps to "fire" gold designs on glass bottles. Ceramics are also being fired at 1,400 F on glass bulbs.

Metal-sheath radiant heaters have been developed in double-element hairpin designs mounted in reflectors. Six of these single elements of different lengths may be combined in pairs to form 27 different heated lengths in one housing.

ELECTRIC WELDING

RECENTLY the Federal Machine and Welder Company delivered the largest resistance spot welding machine of its type to the Ryan Aeronautical Corporation, San Diego, Calif. Designed to make spot welds in aluminum alloys exceeding Government specifications, the machine reaches over 13 feet into the air, and weighs over 58,000 pounds. It is designed with a special throat or work clearance area of approximately 2,100 square inches to accommodate a portion of the tail section of the largest commercial jet airliner now under construction.

Of special interest to electrical engineers is the 25,000 pound 3-phase half-wave rectifier transformer, the largest of this type ever built, which supplies the 100,000 amperes of welding current. The core was constructed of $^{7}/_{16}$-inch-thick mild steel plates, machined for perfect alignment. Since the primary of the transformer is fed from the output of a 3-phase half-wave electronic rectifier at one polarity, an air gap was incorporated in the magnetic circuit of the core to obtain a low value of remanence and prevent saturation. The thick laminations and the air gap required the development of entirely new construction techniques.

The electronic control, which times the duration of the welding current and allows the current magnitude to be varied in increments of 0.1 per cent, was built by the General Electric Company to Ryan specifications.

INDUSTRIAL POWER RECTIFIERS

THE FIRST COMMERCIAL INSTALLATION employing the new triple diametric rectifier transformer connections was placed in service on a chlorine line rated 36,000 amperes, 632 volts. Two aluminum potlines each rated 90,000 amperes, 650 volts will also employ this new triple diametric circuit.

Two other notable trends over the past year have been the widespread acceptance of the new high-capacity sealed ignitrons and the increased demand for both pumped and sealed tubes of the metal-enclosed design, particularly in the higher capacity ratings. The acceptance of metal-enclosed designs had been immediate by industrial users and the trend is now spreading to the electrochemical users for large aluminum potline installations.

MINING AND METAL INDUSTRY

THIS PAST YEAR the Weirton Steel Company, Weirton, W. Va., a division of the National Steel Corporation, took another giant stride in its long-range modernization and expansion program by starting up the fastest and most powerful five stand tandem cold strip mill in history. Equipped to deliver finished steel at a rate of over 7,000 feet per minute, about 80 miles per hour, the mill is driven by d-c motors with a total rating of 28,000 hp.

The higher rolling speeds and larger machinery at the installation required increased automation and greater precision in system performance. An automatic thickness control system takes signals from X-ray gauges and feeds them into transistor–magnetic amplifier–rotating amplifier control systems to regulate strip thickness automatically to a tolerance within a few ten-thousands of an inch even at the highest operating speeds of this mill. Use of the automatic gauge control at Weirton is another significant example of the role automation is playing in steel production today and will play to an ever-increasing amount in the future.

Standard prepunched accounting cards are being used to program roll opening and main drive motor speed for each pass of the metal through a reversing roughing mill. The card is inserted by the roller into a heavy duty industry-type card reader located in the mill pulpit. Operation of a sequencing push button is all that is required to obtain automatic and accurate setting of roll opening and mill speed. Mill operating personnel are enthusiastic over the speed of response, accuracy, flexibility and the quality control possibilities.

During the coming year use of card program control will find wider use on reversing slabbing, blooming, and plate mills as well as reversing roughing mills. Sensing devices such as hot metal detectors and strain gauges will assist the basic numerical control system in sequencing the over-all operation.

PETROLEUM INDUSTRY

USE OF THE STRAIN GAUGE as a pressure pickup to obtain an electrical impulse for remote pressure indication and/or control purposes is rapidly spreading to all industries handling fluids or gases. The accuracy, reliability, and ruggedness of the device and its assorted amplification equipment have been proved in so many applications that in at least one industry—oil and petroleum products pipe lines—it has been accepted for equipment protection.

Modern pipe lines with a number of pumping stations operating in series must have devices at each station to protect the centrifugal pumps against low suction pressure which could cause cavitation and damage the

Conical prismatic elements on this lens control the direction of light output to eliminate glare in high light level installations.

Courtesy Holophane Company, Inc.

pumps, high case pressure beyond that the pump case and fittings are designed to withstand, and high outbound line pressure beyond safe limits of the line pipe. Where strain gauges are already being used to measure these pressures, addition of the protective relays is relatively simple and economical. The low voltage output of the strain gauge amplifier (usually 0–5 volts) which goes to the pressure-indicating meter is simply stepped up to a higher voltage sufficient to operate a suitable relay. Inasmuch as the voltage output is directly proportional to the pressure on the strain gauge, adjusting the relay to operate at a definite voltage will enable an alarm to be given or the pumping unit (or units) to be shut down at any predetermined pressure.

The obvious advantages of this type of pressure-protective system for a wide variety of fluid and gas applications will undoubtedly result in the vacuum tube being introduced into a number of industries where it has not been used before.

Instrumentation

ELECTRONIC AND HIGH-FREQUENCY INSTRUMENTS

ONE OF THE GENERAL TRENDS in the field of instrumentation is that toward making precision instruments for measurements outside of the specific laboratory and engineering areas, with an emphasis being placed on digital data presentation, elimination of all calculations, and simplicity of operation to permit use by unskilled and semiskilled personnel.

New instruments that have been developed during the past year include:

1. An electronic engine analyzer which utilizes a cathode-ray tube display and can be used to study the performance of automobile engines "in the shop" or during road tests.

2. An electronic instrument for quality control in cigarette manufacture which, by combining dielectric measurements and measurements of beta particle transmission, maintains a product with uniform density.

3. A time interval meter for weapons testing which is capable of measuring and printing as many as 150 time intervals per second with an accuracy of approximately 10 microseconds.

4. An automatic impedance plotter for instantaneous recording of real and imaginary components of impedance as a function of frequency, temperature, or other variables. This instrument has a frequency range of 10 cps to 100 kc with an accuracy of 2 per cent for resistance values between 0 and 10,000 ohms and reactances between $\pm$10,000 ohms.

5. A traveling wave cathode-ray tube for photographic recording of transients in the millimicrosecond region which has a sensitivity of 0.2 volts per trace width and a writing speed of 10-inch trace widths per second which permits the recording of pulses with rise times on the order of tenths of a millimicrosecond. The new cathode-ray tube achieves high deflection sensitivity by the rise of a long traveling wave deflection plate system wherein the signal velocity along the plates is made equal to the electron beam velocity, thereby eliminating transit time distortion.

INDICATING AND INTEGRATING INSTRUMENTS

THE DESIGN of a clamp-type a-c microammeter on the part of the Bureau of Standards has been announced. Using a small clothespin-like clamp with a tiny split-core transformer to encircle the circuit under test, the output of the transformer secondary coil is amplified through the use of seven transistors fed from a small 6-volt battery. The full-wave rectified output is indicated on a 200-microampere d-c panel instrument. Scales of 0.2, 2, 20, and 200 milliamperes represent the current in the single conductor being tested with errors of less than 10 per cent of full scale from 150 to 60,000 cycles, with only slightly greater errors at 60 cycles and at 100 kilocycles.

Another new development is the use of amplifier techniques in conjunction with a servo ratio indicator for the measurement of low resistance values. Eliminating the apparatus and manipulation of a Kelvin double bridge, the voltage drops of the current through a standard resistor and the resistor being tested are amplified and their ratio is directly indicated. Of value in adjusting shunts, in making conductivity tests and other work with low-valued resistors, the procedure further extends the use of electronic amplifier methods into the field of basic measurements.

NUCLEONIC AND RADATION INSTRUMENTS

GOVERNMENT BILATERAL AGREEMENTS and the decision to aid in the support of university training reactors, as well as the tremendous interest in nuclear-powered vessels and in broadening AEC and industrial power reactor programs have stimulated a number of studies. The purpose of these studies is to reduce the complexity of instrumentation, to rely more heavily on electrical transmission of measurements, to improve reliability, and to devote more time in reactor training courses to measurements and control.

Development progress encompasses a Bureau of Standards analog computer for radiation fallout measurements and predictions; an atomic "stop watch" used in atomic research, which times events occurring in 1 billionth of a second; a television camera usable inside a reactor shortly after shutdown; measurement components capable of high-temperature operation, which appear unaffected by radiation; a liquid metal pump usable within the nuclear shield; and equipment to measure in animals and men within two minutes 0.001 microcuries,

where permissible amounts may be 1 to 100 microcuries of gamma nuclides.

Improved instrumentation for operating reactors includes liquid-level transmitters for homogeneous reactors, where corrosion and radiation effects are important factors; a mass spectrometer to inventory isotopes in fuel, with minimum hazard to analyst; equipment to detect fuel cladding ruptures, allowing remedies before excessive contamination; and fast responding temperature measuring detectors in concentric-thermocouple form for small size, and rugged resistance form suitable for operation in radioactive high-pressure water.

In general, as the reliability of measurement and control instruments are improved especially in regard to high temperature operation, the art of nuclear reactor control is also improved and improvements have definitely been made in that direction .

Examples of trends toward compactness and sensitivity include transistorized monitors and dosimeter chargers, portable fast neutron monitors, portable time-left-before-serious-dosage monitors, carbon chambers for gammas insentitive to thermal neutrons, and neutron sensitive photomultipliers insensitive to gammas for fast neutron reactors with gammas decades above present reactor values.

Recent revelations of advances relating to controlled nuclear fusion have created a resurgence of interest in gaseous discharges and allied instrumentation such as the use of microwave techniques. It is stated that spectroscopic measurements can give useful information on plasma composition during early fusion research.

Power

POWER GENERATION

DURING 1956, The Cleveland Electric Illuminating Company placed in service at Eastlake Station the first large steam turbo-alternator with liquid-cooled stator conductors, securing at least three times the current-carrying capacity attainable with conventional hydrogen cooling. Improved rotor cooling whereby rotor scoops bring the hydrogen into direct contact with the rotor conductors, in combination with the advanced stator cooling, will permit the construction of much higher rated 3,600-rpm generators within shipping limitations. In the same station, forced-air-cooled isolated-phase bus ducts rated 10,000 amperes between the generator and the transformer achieve very considerable space saving. Several utility companies plan to use steam-turbine boiler-feed-pump drives in order to minimize station auxiliary power problems and achieve over-all economies in operation. The march toward higher steam pressures continues; Public Service Electric and Gas Company's Burlington (N.J.) station went into service at 2,350 pounds per square inch and 1,100 F.

In the hydroelectric field, S. Morgan Smith Company's new high-head turbine test stand permits testing homologous models under heads up to 300 feet and conditions duplicating those in the field. First use of *T-1* steel in turbine spiral casings, with approximately 50 per-cent reductions in plate thickness, with accompanying savings in freight and field welding expense, was made in the Brownlee and Swift Creek plants.

Marked advances are being made in pumped storage developments, notably Hydro-Electric Power Commission of Ontario's Sir Adam Beck—Niagara Pumping-Generating Station with six units rated 45,000 bhp, turbine capacity under an 83-foot head and 5,000 cubic feet per second pump capacity over the full range of head. The Tennessee Valley Authority placed its outstanding Hiwassee pump-turbine unit in full operation. The unit is rated 70,000 kva as a turbine-generator and 102,000 hp as a pump-driving motor. It can generate 80,000 hp under a 90-foot head and pump 3,900 cubic feet per second against a 205-foot head.

Marked advances are being made in the application of gas turbines, especially in large units projected for Canada. Some 413 units are now installed or planned to 1959 throughout the world. The largest projected unit is 40,000 kw in Sweden.

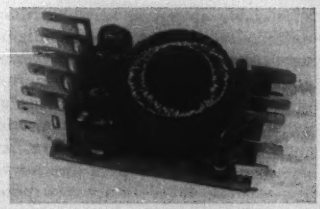
Stepped-up activity in the field of atomic power characterized 1956, with progress on Shippingport and the placing in service of the United Kingdom's Calder Hall Station in October. In the United States, 20 plants of various types are well along in design.

POWER SYSTEM COMMUNICATIONS

IN THE CARRIER LINE, one of the major developments was a new line trap rated 1,600 amperes continuously with a short-circuit rating of 44,000 amperes rms symmetrical, and this current may be fully offset. This trap is made with aluminum conductor and it is approximately the same over-all size as the 1,200-ampere traps.

A capacitor potential device for obtaining up to 500 watts of a-c power from a high-tension transmission line has been developed. Where other sources of utilization voltage are not available, this unit can be used, within its capabilities, instead of a more expensive power transformer to supply any device such as power-line carrier equipment.

Transistorized power-line carrier equipment provides a reliable medium for transferred trip protective relay signals. Transistors, used throughout the entire receiver and in all except the output stage of the transmitter, have indicated considerably longer life than vacuum tubes. The use of these devices, coupled with conservative design, results in the necessary increased reliability



Westinghouse CYPAK static control component, shown with case removed.

One of the rectifier cubicles for the first commercial installation using the new triple diametric rectifier transformer connections.

for this application. The transistorized equipment operates on any frequency in the 40- to 200-kc carrier-frequency range.

Distance relaying using an audio tone channel over a leased telephone line has proved successful during 1956. Such operation may be considered as an alternate in those cases where frequency allocation problems rule out the use of standard power line carrier channels. The telephone line as well as the tone equipment is continuously monitored through the use of a continuous blocking relay scheme.

In the microwave field, a new method was developed to use the time-division multiplexing channel pulse to provide a high-speed relaying function, and applications were made for directional comparison and phase comparison relaying, transfer trip, and supervisory control. This method provides high-speed control without requiring any additional tone equipment, and furnishes continuous monitoring of the channel.

RELAYS

IT WAS ANNOUNCED that the initial use of transistors in a protective relay has opened a completely new field in relay design. The new relay, which will be used to protect large turbogenerators against unbalanced loading has an alarm unit sensitive to negative-phase-sequence current as low as 7 per cent of the full-load current. This sensitivity has been achieved by the use of transistors to amplify contact capacity and demonstrates their effectiveness in providing improved relay performance.

In addition, new lines of induction overcurrent, directional overcurrent, and induction voltage relays in a new reduced case line were developed. The relay case heights have been reduced by approximately one-third, offering appreciable savings in switchboard space. At the same time, mechanical simplicity, self-aligning assemblies, and standardizations have provided fewer adjustments, greater accessibility, and improved performance. Among the numerous electrical improvements are the significant reductions in burdens, minimum self-heating, minimum ambient temperature errors, increased continuous ratings, and a new high-speed directional unit.

It was also noted that several pilot-type relaying installations utilizing microwave channels were installed. Other channels put in operation for relaying were audio tones over pilot wires, and carrier over high attenuation cable.

ROTATING MACHINERY

THE LARGEST CAPACITY 3,600-rpm single-shaft turbine-generator so far produced was put into service at the Gallatin Steam Plant of the Tennessee Valley Authority. This is a Westinghouse conductor-cooled unit having a maximum capability of 319,444 kva, 24 kv at 45 psig (pounds per square inch, gauge) hydrogen pressure.

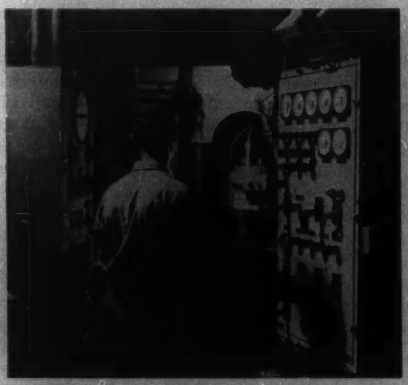
Also installed on the TVA system was the world's largest capacity synchronous motor, rated 102,000 hp, 95 per cent power factor, 105.9 rpm, built by Allis-Chalmers. This machine is used for pump-turbine service at Hiwassee Power Plant and is rated 70,000 kw, 0.85 power factor, as a generator with reversed rotation.

A 260,000-kva turbine-generator having a liquid conductor-cooled stator went into service during 1956 at the Eastlake plant of the Cleveland Electric Illuminating Company. This General Electric unit, the first of its type, also employs a gap pickup type of conductor cooled rotor.

Three 50,000-kva synchronous condensers supplied by Allis-Chalmers operate at 900 rpm, 30 psig hydrogen pressure with substantially the same operating characteristics as conventional 720 rpm, 0.5 psig hydrogen pressure machines.

A direct connected 420-cycle inductor alternator for a 825-kw excitation system was placed in operation with an Allis-Chalmers 75-mw outdoor type turbine-generator unit at the Palatka Plant of the Florida Power and Light Company. Selenium rectifiers and magnetic amplifier controls for this largest excitation system of its type are installed below the generator.

Reliance Electric & Engineering Company, Cleveland, Ohio, has improved its floating worm gear motor which



Courtesy General Electric Company

Automatic thickness control system on 7,000 foot per minute tandem cold reduction mill includes X-ray indicator at left and X-ray gauge at center; operator's cabinet is shown at the right.

has been used extensively for steel-mill runout tables, glass-polishing lines, etc. They also have developed a gear motor for use in Taconite plants and other locations where magnetic and abrasive dust is a problem. Reliance has also developed a 100-hp explosionproof motor having the size of a former 65-hp rating, and a 220-hp explosion-proof dynamometer for output speeds to 50,000 rpm for testing earth satellite components.

Westinghouse Electric Corporation has developed grey iron casting techniques permitting more surface area per inch of frame diameter, thus combining ruggedness and minimum size for a given rating.

The General Electric Company has designed a new line of d-c motors, generators, and motor-generator sets to provide greater versatility, faster speed of response, and increased overload capacity in adjustable speed drives—called the Kinamatic line.

SUBSTATIONS

THE RELIABILITY of supervisory control, indication and telemeter selection systems operating over direct wire channels has been greatly enhanced by a newly developed automatic throwover equipment which detects a short-circuited or open-circuited channel and immediately transfers both the sending and receiving station equipment to a healthy channel. This equipment is available for use in those important installations where the highest degree of service continuity is essential.

The first installation of 13.8-kv 750-mva metal-clad switchgear has been placed in service. This switchgear is of the same basic design, including the use of flame-retardant insulation, as the 500-mva switchgear which was formerly the top interrupting rating. The 50 per cent increase in rating was accomplished with no increase in unit width and with less than 10 per cent increase in floor space requirements.

SWITCHGEAR

SEVERAL MANUFACTURERS have developed and are now marketing 750-mva magnetic circuit breakers with metal-clad switchgear in the 15-kv class.

The advantages of current-limiting fuses and molded-case breakers have been combined in a single device capable of protecting circuits with available short circuit up to 100,000 amperes in the 600-ampere, 600-volt class. The unique feature of these devices is the tripping of the circuit breaker upon the operation of a single fuse, thus preventing single phasing.

Molded case thermal overload circuit breakers are now available in an 800-ampere, 600-volt rating. Air circuit breakers rated at 3,000 amperes, 350 mva in the 5-kv class have been developed to satisfy the requirements of large station auxiliary service.

High-speed grounding switches have been developed for 230-kv service to close 20,000 amperes in less than 5 cycles. The blade operates in a sulfur hexafluoride gas within a sealed porcelain casing. Use of such a device, operated on transformer differential relays, will effect the opening of a remote circuit breaker, thus permitting the omission of a circuit breaker at the transformer.

Newly developed General Electric dual-element high-speed resistance temperature detector for atomic reactor plants.

Higher ampere ratings are now available in isolated phase bus, using forced-air cooling or self-cooled pressurized nitrogen-filled construction.

TRANSFORMERS

SHIPMENTS WERE MADE during 1956 of the first cascade-types of instrument potential transformers to be produced by an American manufacturer (General Electric Company) for power system use. Designed for circuits of 115 kv and above, the new transformers consist of three or more similar sections stacked one on top of the other, with porcelain insulators between them. The primaries are connected in series, with auxiliary windings interconnected so as to divide the voltage equally among the sections. Secondary voltage is taken off the bottom section. In this way, each of the sections needs to be insulated for only one third or less of the total voltage, and substantial savings in over-all size and cost can be accomplished. Performance meets the 0.3 ASA (American Standards Association) accuracy class at burdens up to 200 volt-amperes.

To take care of the increased ratings of transformers, Allis-Chalmers Manufacturing Company has developed a load tap changer which is suitable for use on transformers rated 1.3-million-kva for a 20 per cent range in 32 steps. This tap changer consists of three principal parts: a dial switch mounted on the side of the tank and driven by an intermittent gear, a cam-operated circuitbreaker located below the dial switch compartment, and a motor-driven mechanism which drives the circuit breaker and dial switch. The circuit-breaker rating is increased by using an arc-extinguishing device developed for power transmission breakers.

Another 1956 development in the field of transformers has been the determination of impulse stresses in transformer windings by means of computers. The insulation design of a transformer is largely determined by the distribution of impulse or lightning voltages within the winding. A theoretical basis for determining these stresses has been developed and applied to the design of transformers through the utilization of modern digital and analog computers. The speed, accuracy, and versatility of those computers gives the designer an analysis which is not only highly accurate but is easily obtained. The mathematical basis of the method provides good possibility for further development. Previous methods

Neutron - sensitive photomultiplier tubes practically insensitive to background gamma radiation.

Courtesy Argonne National Laboratory

have used either short approximate calculations or models which were expensive to apply and introduced a large time lag in the design procedure.

TRANSMISSION AND DISTRIBUTION

DURING 1956, co-operative large-scale lightning investigations were initiated. These investigations involve measurements on actual transmission lines in the field, also laboratory investigations and analytical procedures. Special instruments have been developed for measuring the steepness of wave front and surges produced on transmission lines and towers. The investigations will furnish fundamental data on the nature of the voltages produced on transmission lines by lightning and will lead to improved performance of transmission lines in areas of intense lightning.

There is increasing interest in the use of multiple conductors in transmission line construction. This type of construction yields lower line reactance and improved corona and radio noise characteristics with smaller individual conductor sizes. Spreaders, corona shields, and special high-strength insulators have been developed for use on such high-voltage multiple-conductor spans.

Recent economic studies of high-voltage transmission show that the present balance between equipment and line costs favor the construction of transmission systems at voltages higher than those which were economically feasible 10 years ago. These studies also show dual-conductor transmission as attractive economically with economic loadings on dual-conductor lines approximately 25 per cent higher than those obtained with single-conductor transmission.

Another significant development during the past year resulted from a fundamental analytical study of radio influence on high-voltage transmission lines. Explanations were achieved for several phenomena of interest regarding radio influence. One of these, in particular, was the complete accounting for the previously unexplained very large reduction in radio influence observed with multiple or bundled conductors.

Finally, mention is to be made of the effect of the current trend toward further reduction in insulation levels in the transmission voltage range and of the improved characteristics of modern arresters. This trend has underlined the relative importance of switching surges as compared with lightning surges and 60-cycle operating voltages on withstand insulation requirements. As a consequence, switching surges are being intensively studied, classified, and defined, with the objective of specifying a typical switching surge for the evaluation of insulation characteristics. Studies were completed during the year not only on the manner in which arresters would limit and modify certain types of switching surges, but also on the nature of the switching surge duty which might be applied to a modern arrester by a typical system.

Science and Electronics

DIELECTRICS

A NEWCOMER to the field of electrical insulation is a family of materials developed by the Westinghouse Electric Corporation. Based on synthetic resins, these new rubberlike materials are tailor-made for their applications, such as current coils for watt-hour meters and instrument transformers.

In the current-coil application, advantage is taken of the high thermal stability and the rapid molding characteristics of the new materials. An instrument transformer requires a molding compound which provides mechanical protection, good electrical properties, oil resistance, and relative immunity to the degrading effects of ozone, water, and weathering.

Through selection of the appropriate polymer and compounding ingredients, the hardness and other physical factors may be varied over a wide range while retaining the other favorable properties. Though the major use of the polyester elastomers has been by transfer molding techniques, an application has been developed in which the end product is a foam with very good thermal stability.

Solventless silicones were developed jointly by Westinghouse and Dow Corning scientists. They are vinyl-substituted polysiloxane resins, providing thick sections of thermally stable, void-free insulation by impregnation or encapsulation techniques. The polysiloxane backbone provides the thermal stability and good electrical properties, while the vinyl groups are present as a means of converting the liquid resins to crosslinked thermoset solids. Conversion to compact bubble-free solids is effected by the use of conventional organic peroxides. Compactness is essential to the prevention of corona, which would lead to the physical destruction of the insulation. Void-free character is also essential to the ability of the finished insulation to dissipate heat generated within the electrical apparatus. These new resistant resins will permit high-voltage electrical equipment of a given physical size to have higher electrical ratings. Or in applications where weight and space are important factors, the physical size of equipment of a given electrical rating can be greatly reduced, without risking failure through thermal degradation of the insulation.

ELECTRONICS

TRANSITION FROM DEVELOPMENT TO PRODUCTION of a number of advanced electronic systems and components has been an outstanding feature of the year 1956.

In the field of communications, tropospheric scatter propagation, long in the laboratory stage, has become a practical military and commercial communications tool,

with dozens of systems now operating as integral components of established communications networks and even more being manufactured. Components have been developed to extend frequency coverage both higher and lower than previously available. Klystrons capable of generating 20 to 50 kw continuous wave at 200 mc and 10 kw at 2,400 mc have gone into production during 1956.

Broad extension of communication techniques into the microwave region continued. Single side-band transmission pushed on to higher frequencies—even microwaves on an experimental basis—thus helping to assure adequate communication spectra for the future.

Development of a meteor scatter system that can transmit messages up to 1,000 miles was announced. This new technique requires only a fraction of the power of ionospheric scatter systems and promises to be at least as reliable.

Color television continued its rapid expansion with more stations, more receivers, and more programs originated in color. While strides were not as great as originally predicted by some, definite progress was made. Practical television tape recorders were demonstrated during the year and production was begun. Progress was made in adapting tape-recording techniques to color television.

During the year past, a new line of exceptionally rugged ceramic receiving tubes was released. The tubes will withstand heavy accelerative forces of shock and vibration and will operate continuously with envelope temperatures of 300 C.

Computers began to find their way into more and more industrial and scientific organizations and were being developed for many practical tasks such as electronic banking and bookkeeping.

The "radar range" ceased to be a curiosity and moved out of the restaurant and into the home, at least two

Type LVDP plug-in busway recently announced by General Electric.

companies producing substantial quantities during the year.

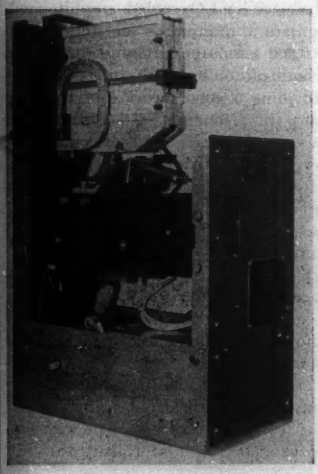
In the field of navigation and radar, klystrons began to replace magnetrons in sensitive situations. The first quantity production of very high power pulsed klystrons was started by several West Coast concerns. Spanning the power gamut, pilot production experience demonstrated the feasibility of manufacturing first stage S-band traveling wave input amplifiers for radar receivers with manufacturer's specified true noise factor of 6.5 db at 3,000 mc. This phenomenally low noise factor was often bettered sufficiently that theoretical performance was actually exceeded by individual production design tubes. Agreement was finally reached on a unified military and commercial air navigation system. Christened VORTAC, it will combine the best features of the VOR-DME system sponsored by the Civil Aeronautics Administration and the military TACAN system. Progress was made on the air traffic control problems partially fostered by a tragic collision of fully loaded commercial airliners. Development of proximity warning equipment was begun and a tight time schedule set which called for delivery of first units in 1958. Weather radar was widely used by the airlines with an appreciable improvement in passenger comfort and reduced operating costs.

Several new guided missiles that rely entirely on electronics for guidance and control went into production.

Solid-state electronics saw the continued development of the transistor. High frequency units and drift transistors became commercially available for the first time. A tetrode with 10 db gain at 100 mc was produced. Solar battery techniques contributed new fabrication methods of gaseous or solid diffusion into pure crystals which permits controllable thin layers to be manufactured.

During the year the p-n-p-n diode was invented. Its unique properties include low voltage drop, making it suitable to replace gas tubes in certain switching operations. Improvements in circuit technology led to use of more transistors in computers and other equipments.

Electron linear accelerator development was stepped up tenfold. Units began to be used for sterilization and industrial processing as well as for research on atomic



Type FB-12 current-limiting high-speed d-c circuit breaker operable at 1,000 volts and 1,200 amperes continuous.

Courtesy I-T-E Circuit Breaker Company

structure. Several medical accelerators operated at about the 6 million electron volt level. Progress in the treatment of malignant growth with high-energy electron beams was very encouraging, presaging a possible new potent tool in the battle against cancer.

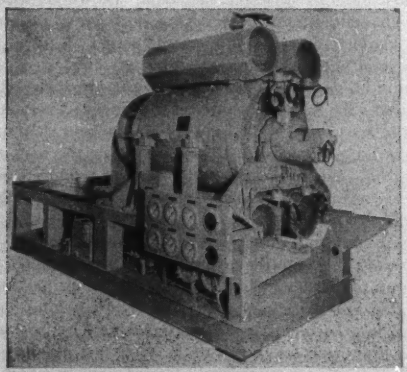
Possibly the most spectacular engineering accomplishment of the year 1956 was the activation of the first SAGE subsector—a beginning on the most ambitious electronic control and communications system ever developed.

MAGNETIC AMPLIFIERS

MAGNETIC AMPLIFIERS have displaced electron tube systems in the past, but usually at the expense of size and weight. During 1956 a twin-section magnetic amplifier was developed which weighs only 1 ounce and measures ¾ inch in diameter and $1\frac{5}{16}$ inches long. Though slightly heavier, this is smaller than miniature twin-triode vacuum tubes. Each section is capable of delivering several watts to its load and the two sections are ideally suited for delivering differential excitation to torque motors, solenoids, or relays. Operating from power supply frequencies in the range of 1,000 to 2,500 cycles, these miniature high-performance magnetic amplifiers will find application in airborne controls particularly in the fields of small jet engines and missiles.

Magnetic amplifiers are also displacing conventional contact-type relays in industrial control systems to accomplish the information processing functions normally performed by the relays. In many automated processes, millions of relay operations occur within a relatively short period of time. Consequently maintenance and reliability may become a major factor.

Any complex system of information processing can be accomplished by combinations of a relatively few basic functions. Small plug-in type packaged units of uniform size have been developed to perform these basic functions statically by means of magnetic amplifiers. A number of these basic static units are readily interconnected to perform the required complex information processing.



Huge 220-hp explosionproof dynamometer designed and built by Reliance Electric and Engineering Company for testing earth satellite components for project Vanguard.

Courtesy Westinghouse Electric Corporation

Glass-reinforced polyesters, having good dielectric strength and high tensile strength, are used in the design of commutator banding for motors. In this application, the pre-impregnated glass roving is wrapped around the coil ends of a fully assembled preheated motor.

This technique provides completely static and nonelectronic control and regulating systems for a wide scope of industrial control applications.

NUCLEONICS

THE YEAR 1956 has been marked by a number of events and developments of special import to the field of electric power generation using nuclear fuels. Notable among these were the allocation of 40,000 kilograms of U-235 by the U.S. Government for fueling, research, and power reactors. Some of this amount will be used by other countries; some for the severalfold expansion of the entire reactor program, both foreign and domestic; and some for the startup of the world's first large-scale nuclear electric power generating station at Calder Hall (England).

The Calder Hall reactor is a CO_2-cooled, graphite-moderated reactor using natural uranium as fuel and is capable of producing 70,000 kw output. Because it was designed to produce both plutonium and power, it is not looked upon as providing a good measure of the true economics of nuclear power. Nonetheless, the Calder Hall reactor is the forerunner of a series of gas-cooled, graphite-moderated, "power only" reactors planned for construction by the British as part of our rapidly expanding power reactor program. This program has been directed toward achieving as much as 6,000 mw nuclear electrical capacity by the end of 1956.

Construction work on the United States counterpart of the Calder Hall reactor, the pressurized water reactor at Shippingport, Pa., continues with completion scheduled for mid-1957. The total reactor program in the United States and other countries of the free world has undergone an enormous growth during the past year. Almost all of the free nations have either ordered or undertaken preliminary planning for a reactor of some type with emphasis on research reactors or small, pilot plant scale (20 mw or less) plants.

The United States reactor program tends to be characterized by the construction of a wide variety of reactor types rather than of a large quantity with emphasis on total kilowatt output. This results from lack of information on the relative economics of the different types.

The Soviet Union announced plans for a very ambitious power reactor building program leading to 2.5 million kw of electrical capacity by 1960. As many as 10 different reactor types are said to be included in this program.

SEMICONDUCTOR–METALLIC RECTIFIERS

SEMICONDUCTOR-TYPE RECTIFIERS have been under intense development throughout the world not only as cells but also in their applications.

As a result of developing higher temperature materials that go into the manufacture of selenium rectifiers, current densities have been raised, resulting in lower costs and smaller rectifier stacks.

Germanium rectifiers are now being manufactured in Europe, following the U.S. practice. As a result of developing hermetic-sealed germanium rectifier cells, water-cooled designs are being announced. This permits larger blocks of power per cubic foot of material—one manufacturer quotes 10 kw per cubic foot and 60 kw per square foot of floor space.

Silicon rectifiers are increasing in size with ratings up to 550 amperes or 300 volts d-c when using six cells in a 3-phase bridge circuit.

Large blocks of power using semiconductor rectifiers have been installed during the year to service the electrochemical industry. One manufacturer has installed over 70,000 kw.

It is apparent that the trend is to semiconductor–metallic rectifiers for power-conversion applications.

SOLID-STATE DEVICES

AMONG THE 1956 DEVELOPMENTS in the field of solid-state devices was a new device which converts X rays to visible light and increases the brightness of X-ray-produced images by 100 times over those obtainable with a conventional fluoroscopic screen, announced by the RCA Laboratories in Princeton, N.J. In this thin light amplifier panel, developed from the original RCA light amplifier, X-ray images falling on a photoconductive layer cause a corresponding pattern of electric current to flow through an adjacent electroluminescent layer which emits visible light in a pattern corresponding to the incident X-ray image. The increased brightness of the screen permits viewing in normally lighted surroundings. Together with the accompanying increase in contrast, an improvement in perceptibility of picture detail is obtained. If viewed in darkened surroundings, it is possible to reduce the X-ray intensity to values considerably lower than those customary for typical fluoroscopic displays. The present device has a speed of response of a few seconds, making it useful in such functions as X-ray inspection of metal welds, castings, and other stationary objects. Further research is expected to produce photoconductive material which will enable greater speed of response and make possible the development of the device for a variety of other industrial and medical uses.

Engineers checking the operation of the memory section of the Datamatic Corporation's $1.5-million data-processing system unveiled in 1956. The system can handle addition of 4,000 sets of 11-digit numbers in a second, or compare 5,000 or multiply 1,000 a second.

The Eimac X590 klystron is shown in its amplifier circuit assembly.

Courtesy Eitel-McCullough, Inc.

Another device the BEPOC (Burroughs Electrographic Printer-Plotter for Ordnance Computing) represents one specific embodiment of the electrographic recording technique. The device is designed to record in page form the output of a high-speed computer in either alphameric (printer) or graphical (plotter) form, or both. The record is made on a continuous roll of 11-inch-wide paper by printing data in dot form. Each dot is 0.010 to 0.012 inch in diameter in a matrix 50 x 50 per inch. The alphameric information, three complete lines, can be recorded during each scan, each character printed in a 5 x 7 matrix, 0.08 by 0.12 inches, five lines per inch, 7.14 characters per inch, or 72 characters per line. If graphical information is recorded, the normal format allows ½ inch of the 10½-inch wide record for legend with a plot area 10 inches wide and as long as desired. Provision is made for recording faint graph lines at five lines per inch in each of the two co-ordinates.

What Engineers Expect from Management

H. L. RUSCH
ASSOCIATE MEMBER AIEE

J. R. GOEKE

As the engineer assumes a more and more important role in industry, it becomes increasingly evident that harmonious relationships with management are essential. Results are given of a survey on this subject conducted among more than 800 engineers in some of the larger American corporations.

THE EXTRAORDINARY GROWTH of the engineering profession since World War II has brought with it some real growing pains. One of the areas where stress has been felt most acutely is the relationship between engineers and management.

In order to explore some of the dimensions of these relationships in industry today, we made an extensive survey recently. Comprehensive interviews were conducted with more than 800 engineers in the larger corporations. This was a representative sampling of engineers in five major industries: aircraft, automobile, electric machinery, petroleum refining, and steel—distributed in industrial centers from coast to coast. Also included were seven homogeneous engineer groups affiliated with leading American companies. Absolute anonymity was guaranteed the respondents, and they spoke very frankly.

These engineers are industry's qualified professional, technical, and scientific personnel holding nonmanagerial positions. They are well educated and highly articulate, and they know what they expect from management. Herein we present their specific opinions, many of which come right down to human relations factors.

The growth of the profession results, of course, in expanding career opportunities, and the engineers recognize this. Specifically asked whether engineering is more attractive today, 69% (per cent) say that it is, as can be seen in Chart A; only a small minority, 14%, say it is less attractive.

Among the men of long experience—those 45 years of age and over who remember an earlier era—a large majority of 80% say engineering is more attractive today than it was 10 or 15 years ago.

Most prominent in engineers' thoughts are the enlarged horizons for the engineer and the greater professional and material recognition these are bringing. Typical comments:

"Engineering work has assumed a greater position in industry and, therefore, there is greater opportunity to do significant, creative work and obtain greater compensation."

"The technological advancement of our country has been very rapid and has brought about the need for specialists in a great number of new engineering fields."

TOO MUCH ROUTINE

TOPPING THE LIST of the engineer's spontaneous complaints is the charge that he is forced to fight his way through a jungle of administrative red tape and onerous routine. His creative energies and productive drives too often ebb away in the struggle with clerical detail. Asked what things they least like about their jobs, almost half of the engineers reply in words like these:

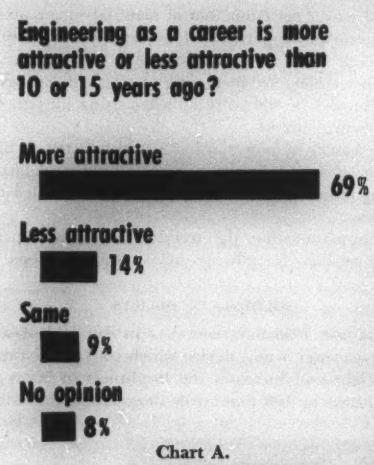


Chart A.

"I like least the innumerable details involved in writing and editing departmental reports for submission to top management . . . much of this work could be performed by statistical clerks."

"Much of my work consists of detailed calculations and accounting details . . . There is simply nobody to delegate clerical chores to."

In one portion of the interview, we asked the engineers to state whether a series of individual statements about their jobs were true or not true. Citing their own experi-

A special article recommended for publication by the AIEE Committee on Management.

H. L. Rusch and J. R. Goeke are with the Opinion Research Corporation, Princeton, N. J.

How engineers vote on a series of statements about their job:

	True	Not True	No Opinion
"Engineers are given too much routine work"	77%	21%	2%
"Pay not high enough compared with other positions requiring same or less ability"	76	19	5
"Engineers are not kept properly informed of company policy"	61	37	2
"Too little chance to use creative abilities"	45	53	2
"The company does not help to further his education"	44	54	2

Chart B.

ence, 77% agree that "Engineers are given too much routine work," as shown in Chart B.

ARE ENGINEERS FAIRLY PAID?

SECOND IN HIS LIST of complaints, as is also indicated in Chart B, is the question of pay. As we note here, 76% of the engineers interviewed say their pay is not high enough compared with other positions requiring the same or less ability.

More than four engineers out of every five who participated in the survey are earning $6,000 per year or more. As a group, therefore, they stand fairly high on the national income scale. But the engineer's testimony about his salary makes it clear that management's pay policies fall considerably short of fulfilling his expectations. When talking about his pay, the typical engineer does not use the vocabulary of the financially oppressed ("I'm not making a living wage"; "can't make ends meet"; etc.) Instead, he concentrates on salary injustices in relation to his experience, and compared with what other groups on the company payroll are earning.

To many engineers, the only way to keep climbing up the financial ladder is to move over onto the management rungs: "The salary curve flattens out for experienced engineers except in solely management positions."

Following are some specific comments about the engineer's pay when he thinks of himself in relation to other professions and trades:

> "The charwoman in our section is paid $80 a week; a starting engineer is paid $100-$120, depending on degree, etc."
>
> "My main gripe is pay scales—a truckdriver . . . milkman makes approximately equal money with no requirements of a formal education."
>
> "In this area, a carpenter, one of the lowest paid of the building trades, receives $540 per month for a 40-hour week. Compare this with the starting salary of a B. S. or M. S. engineer!"

These complaints are not confined to a mere handful of engineers. They are voiced by the great majority, as noted in Chart B.

Clearly, today's engineer expects management to do some basic recalculating—if only in response to the law of supply and demand. In one company where dissatisfaction with pay is especially keen, some engineers come right out with it. Their most effective way of getting a raise, they admit, is by taking a higher-paid job at another company in the area; after a decent interval they can return to their former company at a "pirate" rate.

But it is characteristic of the engineer to feel uncomfortable about such practices. He is not so intent on making a higher salary *per se* as he is on gaining the kind of recognition his background qualifications and professional contribution deserve. To the engineer, pay seems to be almost as important a status symbol as it is a means of acquiring the material goods of life.

Third in the list of criticisms about his job, as is brought out in Chart B, is that 61% say, "Engineers are not kept properly informed of company policy." In other words, they are not advised of what is happening outside of their own work. Hence, it is not too surprising that the engineer wonders if his professional contribution is getting full recognition.

PROFESSIONALISM AND RECOGNITION

LIKE ALL HIGHLY EDUCATED MEN with a sense of dedication to important work, the engineer wants and expects professional recognition. Threading through many of the engineer's frustrations is the belief that management does not give enough recognition to his professional status.

His attitude toward his job is inherently creative; his skills and knowledge are laboriously acquired; the demands upon him for keeping abreast of the technological revolution are growing. Furthermore, he has a profound consciousness that the future of industrial society may very well lie squarely in his hands. And toward his profession the engineer feels a very real sense of dedication. A project engineer in aircraft parts says:

> "Engineers want most of all to be given a job of wide scope which taxes their abilities, their creativeness or talent—as you wish. A heavy workload of this nature is refreshing. A boss who can teach and will teach is an inspiration."

And apparently his kind of recognition is not desired by the engineer solely for the personal gratification it may afford. An electrical equipment design engineer states:

> "Engineers, as they say, are a strange breed of cats.

Money is not their primary goal. What they want most of all is professional recognition. They are willing to devote their whole lives to study and work because they enjoy what they are doing."

Yet it is precisely on this score of professional recognition that management draws the most consistent criticism from the nation's engineers. This criticism, with an insistent, almost angry, undertone runs the gamut from feuding between production and engineering to crowded working conditions. An engineer in air reasearch comments on departmental rivalry:

"I do not like the rivalry between production and engineering—it's useless and expensive. I do not like the production people telling engineers whether or not thy will accept a change. If an engineer proposes a change, it is usually after giving it much consideration."

In a nonferrous metals company, a research engineer expresses the majority opinion of an entire department:

"The company regards engineers as a necessary evil, in a friendly way, of course. Management thinks the point of view of engineers is typical of the species and must be tolerated."

Scientists in a prominent oil company direct their fire at shoulder-shrugging superiors. One of them said:

"I feel that the nature of my work and the tenure I have should give me more recognition from my superiors, but I get little credit for the work produced."

Another sums it up tersely:

"Management ignores our individual complaints until the howls are widespread."

Engineers in a metal parts fabricating company cite the engineer's low prestige compared with other groups, and on status symbols such as parking privileges. Some typical comments are:

"In this company the prestige of engineering is near the bottom, compared to manufacturing and sales."

"We should have at least equal parking privileges with employees getting the same pay in purchasing, sales, finance, and personnel departments."

In a West Coast oil company, a strong sense of being shoved around emerges in word portraits like this:

"There is much time wasted in meetings due to big shots' conjectures on items they know too little about; too many Chiefs, too few Indians! Contempt is shown by nonengineering brass to cold facts developed by engineers."

COLLECTIVE BARGAINING

TOP AFL-CIO UNION LEADERS have been spearheading appeals to engineers and scientific personnel to "join up with us." These drives have caused management considerable concern. The major engineering societies have been exploring the subject with their memberships. Unionization is, from certain angles, a symptom of morale deterioration among professionals that can interfere seriously with productive work spirit.

Although engineers can and do join unions or comparable associations, to date the results of these organization efforts have been spotty. Some professionals have been swept into collective bargaining units along with technicians and other nonprofessionals. More commonly, the professionals have set up independent "associations" for collective bargaining. The principal national body of the independents is the Engineers and Scientists of America (ESA).

Leaders in the top tier of industry's engineers have spoken out plainly against unionization of professional people. But the fact is that scientific personnel employed by a number of the nation's outstanding corporations have elected to unionize at some locations and to engage in collective bargaining with management. Hence, it is pertinent to inquire: What is the current thinking regarding unions and collective bargaining across the board in the engineering profession?

In order to obtain some indication of how many of the engineers in the survey have current experience with professional unions, we asked, "Do any engineers where you work belong to an Engineer's Union or council or association for similar purposes?" A large majority of 71% say "No," 16% say "Yes," and 13% say they "don't know."

When they were asked what they thought about joining a union or a comparable organization, the great majority reject collective bargaining as the way to advance their cause. Many replied with considerable heat that they can take care of their own interests. The idea of unions for their group goes against the grain of the engineers' professional pride. Some typical comments were:

"Most engineers are sufficiently independent thinkers to object to surrendering totally their personal responsibility for decisions which affect their lives and their working conditions."

"The make-up of an engineer and the unionization of engineers seem incompatible."

"Unions reduce incentive by placing all on a common level of mediocrity."

Because of the importance of the subject, all the engineers interviewed were given an opportunity to express their views on four basic statements about unions, pro and con, and the results are indeed very enlightening. One of these statements, summarized at the top of Chart C, was, "Because companies employ large numbers of engineers today, the individual engineer needs some sort of union or similar association to represent him."

As indicated in the chart, 71% disagree, whereas only 17% agree; 12% have no opinion.

Posing this question another way, "Unions or similar

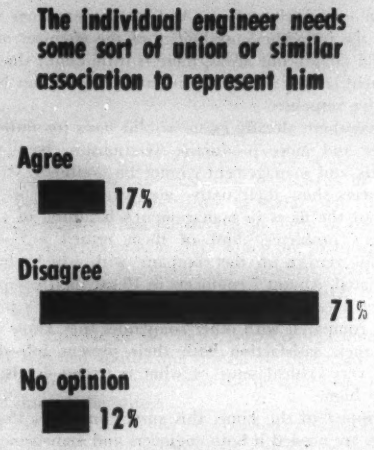


Chart C.

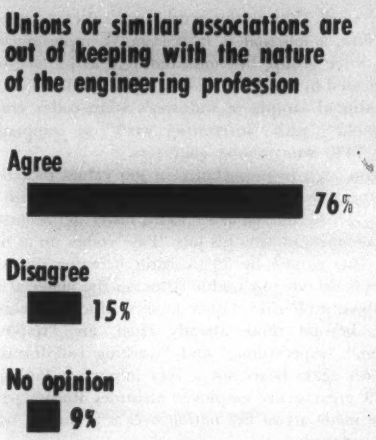


Chart D.

associations tend to be out of keeping with the nature of the engineering profession", again we note strong support for the belief that labor unions are intrinsically out of gear with engineers' professional and individual values. As we see in Chart D, 76% agree with this, and only 15% disagree.

Typical comments further bearing out this point of view are:

"Individual ability, ambition and foresight are the engineer's best help, not unions."

"Unions will advance the cause of the average man, but penalize the aggressive."

It is worthy of comment that among the engineers who are members of one or more of the principal professional societies, only 14% favor a union, whereas among the nonmembers, 21% do.

Also, among those who rate relations with managements excellent, only 10% favor a union for engineers, whereas among those who say these relations are poor or only fair, 25% favor a union.

As might be expected, the chief spark for unionizing is the appeal for "more pay." This reason for unionizing is cited more than three times as often as any other. Although pay is not the main key to engineers' job satisfaction, "injustice in pay" can and often is whipped up as a powerful rallying force for the union idea.

Also worthy of particular comment is the fact that the sentiment for unionization of engineers varies considerably from company to company. Among the seven groups of engineers within widely separated leading companies, the vote of these groups in favor of a union varied all the way from 11% to 41%, indicating that management's handling of engineers can be a very important factor in his thinking about the collective bargaining issue.

Returning again to specific job values in the minds of engineers, one test used to gain further insight into their thinking was an evaluation of 12 job ingredients including many on the nonmaterial side of the job package listed in Chart E. Each engineer was asked, "Which of these job characteristics do you like most about your job? Select several if you wish."

As we see in the chart, two job values stand well above all the others; the work itself and the people with whom

What job values the engineer likes most:

	% Naming this item
Interesting work	74%
People he works with	63
Security	40
Employee benefits	40
Amount of responsibility	37
Immediate supervisor	35
Working conditions	32
Chances for advancement	31
His pay	23
Credit for good work	18
Opportunity for further education	12
Personal interest company takes in him	8

Chart E.

they work. "Interesting work" was selected by 74%. To be sure, a job that is interesting is important to every employee group, but outstandingly so for engineers, as indicated by comparative data from parallel tests. Among a national sample of industry's white-collar employees, only 42% pick "interesting work" as compared with this 74% vote among engineers.

Also high in importance in job values picked by the engineers were the people he works with, with a 63% vote. Third, but some 20 points lower, is "Security"—the opportunity to keep his job. "Pay" comes up as ninth on the list, named by 23%, again bringing out that engineers do not put undue stress on the material rewards of their profession. Other factors which come ahead of pay, beyond those already cited, are "responsibility given," "supervision," and "working conditions."

This again bears out a very important finding based on a great many employee attitudes studies which we have made across the nation over a period of nearly 20 years, namely:

> "Pay is and always will be an important job ingredient, but it is not the uppermost factor in job satisfaction. In community after community, we have found that the company that pays the highest wages is not necessarily the place where people like most to work."

In conclusion, it would appear that each company must seek its own special solutions to the problems faced by the engineering group. And where companies reckon with the individual psychology of the engineer and his special talents and needs, there is little doubt that management can go a long way toward bringing out his full creative response.

That there already exists a solid basis for building a better and more productive relationship between engineers and management cannot be doubted. Although engineers show their native analytical ability in pointing out the flaws in management's handling of the engineer's problems, most of them return a favorable over-all verdict on the company with which they are associated. Almost 7 engineers in 10 say their company is "above average" or "one of the very best" as a place to work compared with other companies they know about, and their satisfaction with their present job—despite their very critical sense of what is wrong—is also relatively high.

Stripped to the bone, this survey indicates that two things are needed if both engineers and management are to make the most fruitful use of their productive relationship. Management must understand what the engineer expects, and know that his expectations are high. But the engineer must also learn to view his own job as management is forced to see it—in the light of the complex requirements of the entire business which must prosper as an organization if its various members (engineers included) are themselves to grow in stature, be prosperous, and be happy in their work.

Lightest Army Radar Detects Enemy in Dark

A lightweight, portable radar which enables a front line foot soldier "to see with his ears" has been developed at the Sperry Gyroscope Company for the U.S. Army. This device provides localized battle area surveillance of enemy movements despite a curtain of battle smoke, darkness, or fog.

In place of the usual radarscope which displays the visual signal on a luminous screen, radar signals are converted into sounds of distinctive character in the headphones of the set, enabling operator to detect the difference between fixed and moving targets at varying ranges up to three miles. Moving enemy vehicles are easily distinguished from foot patrols and, in the hands of trained ground operators, the set can discriminate between track-type treads and ordinary wheels.

This equipment literally provides night-time eyes and ears for the protection of exposed ground troops. In scanning any suspicious sector, it warns of any movement, reveals the path of motion and probable nature of the moving objects and in addition supplies elevation and range data with an accuracy of better than 25 yards. It can detect a single man walking a half-mile away. An enemy's prospects for obtaining the advantage of surprise are now greatly reduced. Here, Pfc Anthony Devlin of Woodside, N.Y. operates equipment while Pvt. Thomas Hughes of Kearny, N.J. tracks "enemy" movement on a plotting board.

Radio Interference of Bundled Conductors

G. E. ADAMS
ASSOCIATE MEMBER AIEE

IT IS EXPECTED that extensive application of bundled conductors will be made to extra high voltage lines of the future when considered in terms of the successful operation of present lines which are so equipped. In particular, lines equipped with bundled conductors have been found to perform very favorably with regard to the production of corona and radio interference. Hence, an analysis of the radio interference characteristics of bundled conductors should be of considerable interest to those concerned with the design of the transmission lines of the future.

This analysis gives a clear explanation of the behavior of bundled conductors as compared with the behavior of single conductors. For bundled conductors, in addition to the considerations necessary for single conductors, the effect of the nonuniform distribution of voltage gradient around the circumference of the conductor upon the radio interference generation must be taken into account. As a typical example, Fig. 1 illustrates the variation of the surface-voltage gradient with the distance around the circumference of the conductor for several different values of center-to-center spacing m. Fig. 2 shows the variation of generation density with the distance around the circumference of the conductor, as calculated for $m = 18$ inches. Experimentally, values of radio interference generation for bundled conductors can be determined by tests made upon single conductors which are suspended either in a cylindrical cage or above a ground plane.

By supplementing the field and laboratory test data which are presently available with certain assumptions as to the nature of the generation density, several numerical calculations were made from which the following conclusions can be drawn:

1. At 350 kilovolts, single 1.75-inch, dual 1.108-inch, and triple 0.783-inch conductors give comparable interference levels. These conductors are standard ACSR (aluminum cable, steel reinforced) sizes which have aluminum cross-sections of 1,414 thousand circular mils (MCM), 795 MCM (1,590 MCM per phase), and 397.5 MCM (1,192.5 MCM per phase), respectively.

2. At 400 kilovolts, single 2.10-inch, dual 1.25-inch, and triple 0.904-inch conductors give comparable interference levels. The dual conductor has an aluminum cross-section of 2,340 MCM per phase as compared with 1,500 MCM per phase of the triple conductor.

3. If all the conductors are assumed to be "solid," the total aluminum cross-section per phase for the same radio interference decreases as the number of conductors per phase increases. In fact, at 350 kilovolts, the total cross-section for a triple conductor is less than that of the single 1.75-inch "expanded" conductor.

4. For lines designed according to typical practice, the dual 1.25-inch conductor at 400 kilovolts represents a more conservative design regarding radio interference than the single 1.75-inch conductor at 350 kilovolts.

Although they are not verified as yet by field test, these calculated results are of considerable practical importance and seem to warrant further investigation in the field and in the laboratory.

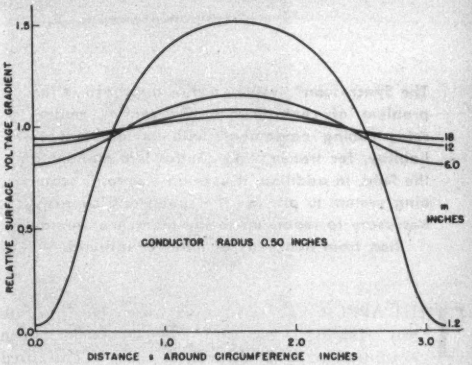


Fig. 1. Distribution of surface voltage gradient for a dual conductor having a total surface charge of Q coulombs.

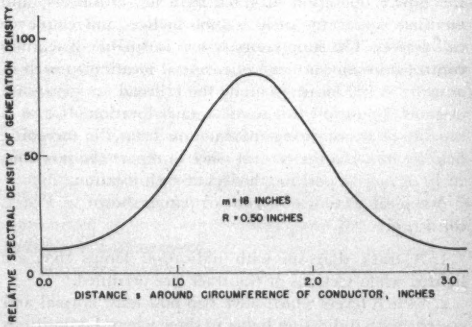


Fig. 2. Variation of generation density around the circumference of a dual conductor.

Digest of paper 56-994, "An Analysis of the Radio Interference Characteristics of Bundled Conductors," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, February 1957.

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SYNCROSCAN

A High-Speed Control System for Railway Signaling

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MEMBER AIEE

The Syncroscan* system, a new approach to the problem of centralized traffic control, retains relay coding equipment, with its inherent reliability, for transmitting control information to the field. In addition, it uses an electronic scanning system to provide the speed and capacity necessary to report up-to-the-moment information from hundreds of miles of railroad.

THE APPLICATION of supervisory control to railway signaling is exemplified by the system known as centralized traffic control, or "cTc." Centralized traffic control is the operation of trains over a division, or portion thereof, by the use of signal indications under direct supervisory control of one operator at a control and indicating machine. This operator can also control the power operation of track switches, crossovers, and auxiliary apparatus such as snow-melters and employee call devices. The supervisory system is capable of sending control information from one central location to each of as many as 100 locations along the railroad to operate six or more 2-position functions at each location. It also is capable of transmitting information from the foregoing field locations to the central office to report the positions of 10 or more 2-position devices at each location.

A typical section of a control panel, shown in Fig. 1, consists of:

1. A track diagram with indication lamps that are lighted when sections of the track are occupied.
2. Switch levers which have two positions, normal and reverse, with indication lights to show when the positions of the levers and their respective track switches do not correspond.
3. Signal levers which have three positions—normal, left, and right—with indication lights to show when the signals are clear.
4. Start buttons, one for each signal lever, which are pushed to start a control cycle after switch and signal levers have been positioned for the route desired.

To position a track switch in the field, the control machine operator moves his switch control lever. An out-of-correspondence lamp in the barrel of the switch lever is illuminated, indicating that the lever is not in correspondence with the switch machine. The control is transmitted to the field location and the switch moves to the called-for position. An indication is sent back to the control office reporting that the change has taken place and the correspondence lamp in the switch lever goes out. To clear a signal for a train movement, the control machine operator positions his signal control lever to the left or right, depending on train direction. The control is transmitted to the field location to clear the wayside signal. An indication is sent back to the control office, illuminating a green lamp above the signal control lever. These two controls, as well as additional ones, can be transmitted in one operation with most control machines.

This method of railroad operation was invented in 1927 at which time dozens of line wires were required to transmit the control and indication information. Between 1927 and 1955 coded systems using relays have been developed capable of performing the foregoing functions by transmitting codes of d-c pulses over two or three line wires. These codes consist of sequences of pulses differing either in polarity, duration, separation, or a combination of these qualities. These coded d-c systems are capable of transmitting one cycle of either control or indication information between one field location and the central office in about 4 seconds. A typical cycle consists of 6 or 8 pulses to select or register a location and 10 or 8 pulses to convey the information.

Relay cTc systems are generally diplex and can communicate with only one field station at a time. Provision must be made to insure that control and indication cycles are transmitted one at a time, even though it is possible for two or more field locations to start to transmit simultaneously and, at the same time, the control machine operator may initiate a control cycle. Inasmuch as control cycles and indication cycles must use the same coding apparatus on a time-sharing basis, it is possible for indication information to be delayed as much as a minute or so on a busy system.

The present trend in railroad operation is to control longer sections of railroad including interlockings (such as a universal crossover layout on a four-track line) from one central office under the direction of one operator. The application of all-relay supervisory systems to these modern installations requires the simultaneous use of several systems multiplexed on a single pair of line wires by means of carrier-current equipment, or an increase in the coding speed of the relay equipment, or both.

Essentially full text of a District paper presented at the AIEE North Eastern District Meeting, Rochester, N. Y., May 2-4, 1956, at a session sponsored by the AIEE Committee on Wire Communications. Recommended for publication by the AIEE Committee on Land Transportation.

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*Registered U.S. Patent Office

DESCRIPTION OF SYNCROSCAN

THE SYNCROSCAN SYSTEM is a new approach to the centralized traffic control problem retaining relay coding equipment, with its inherent reliability, for transmitting control information to the field and using an electronic scanning system to provide the speed and capacity necessary to report up-to-the-moment information from hundreds of miles of railroad.

Since the requirements of a signal supervisory system are divided naturally into two phases, control and indication, it is logical to apply different methods to the operation of the two phases. The control phase requires that the system be capable of transmitting commands originating with one operator to each of many field locaitons. Because the operator is capable of planning a move at only one location at any one moment, a system that can transmit the controls necessary to position a track switch and clear a signal in 1½ seconds is rapid enough to handle the control phase. This requirement is met by a control system using few relays and operating these relays at a speed that will insure long life.

The relay system for controls is much less complex than that used in earlier cTc systems because it no longer has to handle indication information. This system uses mechanical oscillators to establish a common time base at the control office and at all field locations. The control cycle consists of applications of positive or negative voltage to the line during each of 16 time intervals established by these oscillators. The 16 time intervals are counted by a 4-relay binary counter, the first few steps being used for station selection and the remaining steps being used to control the field functions at a station. Thirteen steps are usable to transmit this message. The remaining three steps include period-of-rest and start and stop intervals. A typical control comprises six steps for selection of any one of 64 stations and seven control steps, on any one of which a positive line voltage will operate a field function to one position and a negative line voltage will operate the field function to the other position.

The indication phase requires that up-to-the-moment information be reported from as many as 100 different locations situated along 100 miles or more of busy railroad with a dozen or so trains moving simultaneously. This requirement suggests the use of an indication system, separate from the control system, with the ability to report several hundred bits of information with a maximum delay of not more than 10 seconds between the time of any field change and its display on the control machine panel. An electronic scanning system operating continuously is a very simple means of fulfilling these requirements.

The indication system operates by sending pulses of carrier current from the central office to the field locations, each pulse initiating a response from some field location which will report the position of one 2-position device at that field location. This interrogation and simultaneous response takes place at the rate of 100 pulses per second. The responses from the field are transmitted on one carrier-current channel time-shared by all field locations. Each field location may comprise one or more indication stations, a station consisting of a sequence of 10 indication pulses. Each indication pulse may be transmitted at the higher frequency edge of the carrier channel or at the lower frequency edge, a separation of about 500 cycles per second.

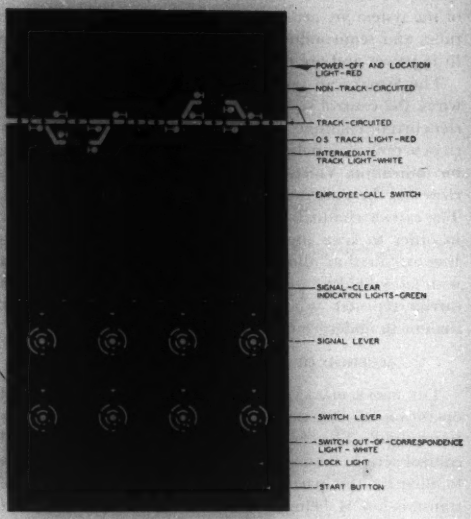


Fig. 1. Typical cTc control panel.

If the device whose position is being reported is represented by an open contact, the pulse representing this device is transmitted at the higher frequency and a corresponding relay at the central office is de-energized. If the device is represented by a closed contact, the pulse is transmitted at the lower frequency and the relay at the central office is energized.

The pulse-counting, switching, and storage functions

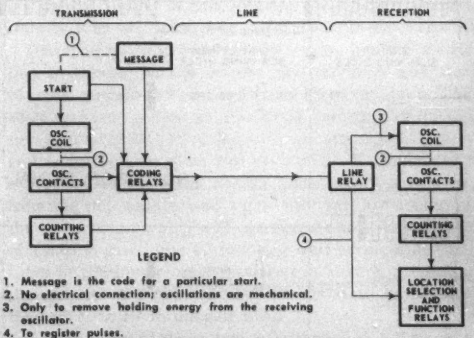


Fig. 2. Block diagram showing basic operation.

of the system are accomplished by means of cold-cathode tubes and semiconductor diodes. These components use little power and are reliable.

The Syncroscan system operates over one pair of line wires, the control system using direct current or one carrier-current channel. The indication system uses two carrier-current channels, one for synchronization and one for indication. Voice-frequency telephone and other carriers may be operated over the same pair of line wires. The carrier channels are generally operated below 20 kc in order to keep the line attenuation low. Minimizing line attenuation allows operation over longer distances with more field locations before repeaters are required. A carrier repeater is available for operation over longer lines or in underground cable.

METHOD OF TRANSMITTING CONTROLS

THE BLOCK DIAGRAM, Fig. 2, illustrates the sequence of operation of the various functions when a control is transmitted. The "message" is the code for the desired control action. It consists of (1) a station selection portion to identify the particular field location to which the transmission is being directed, and (2) the individual controls for the switches and signals which are to be operated. A control cycle normally includes all of the individual controls required to establish a particular route and clear the signal for that route. Before starting a control cycle, the switch levers for the desired route are operated and the signal lever placed in a clear position. The start button associated with the signal lever is pressed and the control cycle is transmitted. If the system is already transmitting a code when the start button is pressed, the controls are stored and are transmitted as soon as the cycle in progress has been completed.

A start removes holding energy from the coil of the office oscillator and opens the line circuit which start the oscillators at all field locations. The contacts of all these oscillators open and close in synchronism, and relays at each location operate to count the steps of the code. At the transmitting end, the coding relays are controlled by the oscillator contacts in combination with the counting relays. This arrangement determines when the coding relays should operate. The message determines how they should operate, that is, whether the line should be energized with a positive or a negative pulse during a particular step. The line relays at all field locations follow the operation of the coding relays at the office. These line relays are of the 3-position polar type. Each relay has two armatures, one of which is actuated when the line pulse is positive, the other when the line pulse is negative. With no energy on the line, neither armature operates. Each time the line is energized during a control cycle, the impulse is used at the field stations to control a location selection relay or to operate a control relay for a switch, signal, or other device.

METHOD OF SCANNING INDICATIONS

FIG. 3 IS A TIME PROGRAM DIAGRAM showing the pulse signals transmitted over the two carrier-current channels providing continuous scanning of indication information. The synchronizing signal consists of station pulses transmitted at LOW frequency, step pulses transmitted at HIGH frequency, and a period of no signal which denotes the start of a new scanning cycle. The LOW and HIGH frequencies are separated by 500 cycles per second.

The indication signal consists of groups of 10 pulses transmitted in the time intervals between station pulses. Each group of 10 pulses conveys information regarding the positions of 10 two-position devices at a field station. The message from a given station is identified as to sta-

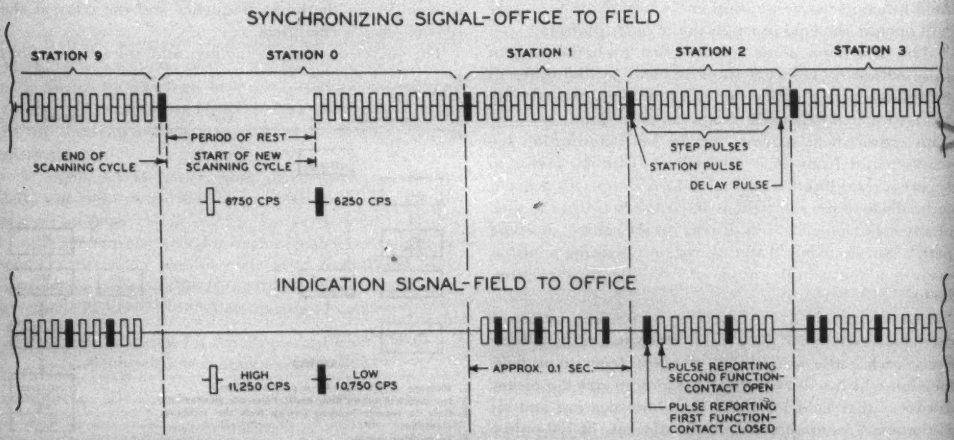


Fig. 3. Time program diagram.

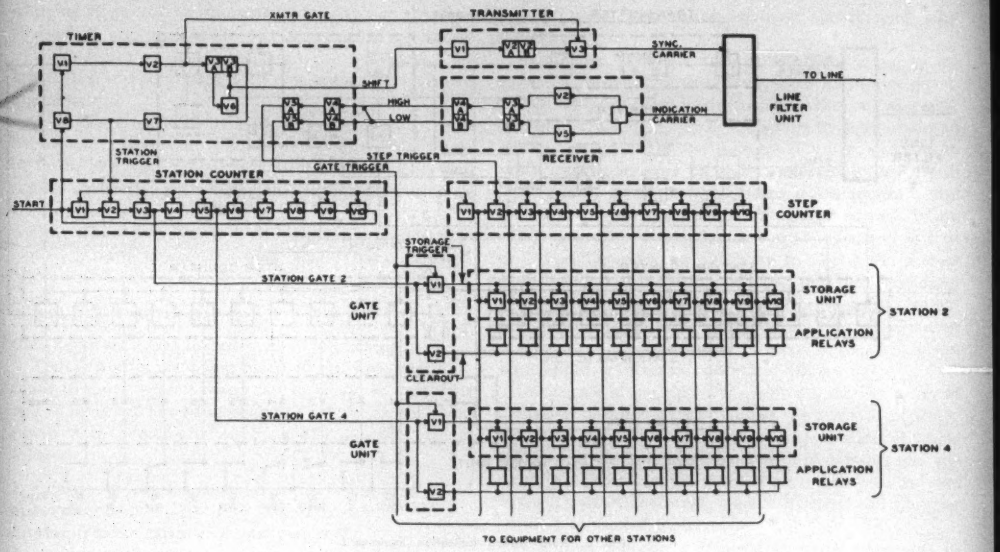


Fig. 4. Control office indication equipment.

tion number of its location within the scanning cycle.

Fig. 4 is a block diagram of the indication equipment at the control office for a 10-station system. Tube *V2* in the timer generates pulses at a rate of 120 per second which are fed to the carrier transmitter, causing step pulses to be transmitted (Fig. 3). These pulses also drive cold-cathode glow-transfer counting tube *V6*, which produces one output pulse for every 12 input pulses. This output pulse is applied to the shift input of the transmitter to cause a station pulse to be transmitted, and to tube *V8* in the timer to drive the station counter. The transmitter circuits are so arranged that the application of voltage to the gate input produces HIGH frequency output while simultaneous application of voltage to the gate and shift inputs produces LOW frequency output. The station counter is a ring counter comprising 10 cold cathode tubes. After 10 station pulses have been counted, a pulse is applied to tube *V9* in the timer which triggers a one-shot multivibrator, tube *V1*, causing tube *V2* to cease generating pulses for approximately $\frac{1}{10}$ second. The circuitry described thus far generates the synchronizing signal shown in Fig. 3.

Fig. 5 is a block diagram of the indication equipment at a field location in a 10-station system. The carrier receiver has conventional discriminator circuits associated with tubes *V2* and *V5*. Tubes *V3* and *V4* are pulse shapers and cathode followers providing separate output circuits for step pulses (HIGH) and station pulses (LOW). The station pulses (LOW) are shaped by tube *V4* in the scanner and applied to the station counter driving it in synchronism with the station counter in the control office. The station selection and station gate wires are connected to the proper stages of the station counter to cause indication pulses to be transmitted at the time desired. In Fig. 5 these jumpers are connected to initiate transmission in station period number 4. As tube *V5* in the station counter becomes conducting, gate tube *V3* in the scanner allows tube *V1* to feed step pulses to the transmitter and to drive the step counter through tube *V2A*. The step counter feeds pulses through the diode unit and indication contacts to the shift input of the transmitter, causing the pulses reporting closed relay contacts to be transmitted at the lower edge of the carrier channel. After 10 pulses have been transmitted, gate tube *V3* retires the station until the next scanning cycle. At the end of each scanning cycle, the period of rest, Fig. 3, is detected by tube *V2B* in the scanner and shaped by tube *V5* to reset the station counter to zero, insuring that the field station counter is in step with the control office station counter.

Referring again to Fig. 4, the indication signal from the line is detected in the receiver and the HIGH and LOW outputs are shaped in tubes *V5* and *V6* in the timer. The HIGH and LOW pulses are combined and applied to the step counter. The LOW pulses only are sorted into station groups in the gate units and applied to all tubes in the storage unit for a given station. Coincidence of a pulse from the step counter and a gate unit will fire a tube in the storage unit which will energize a relay. At the start of a station gate, tube *V2* in a gate unit extinguishes any tubes in the storage unit that are conducting, preparing the unit for the new information about to be applied through tube *V1* in the gate unit.

The capacity of the system is increased to 100 stations by the addition of a cold-cathode ring counter (identical

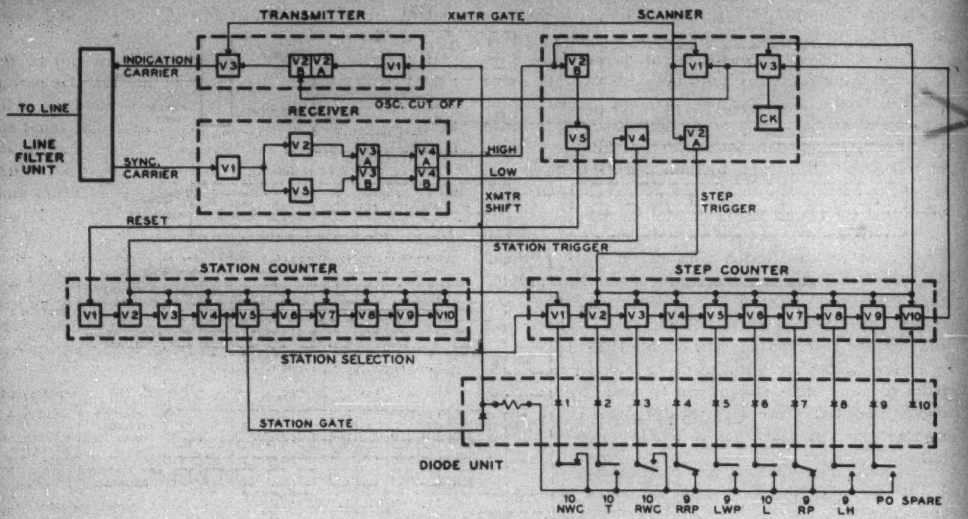


Fig. 5. Field station indication equipment.

to the station counter) at the control office and at each field location. The apparatus at a field location can be made to report additional groups of 10 indications (stations) by the addition of diode units and station selection jumpers, Fig. 5.

ELECTRONIC TECHNIQUES IN RAILWAY SIGNALING

THE RAILWAY SIGNALING ART has been slow to adopt electronics because of the stringent requirement of high reliability and safety. Signaling systems using relays are highly developed and have established excellent records of long, trouble-free operation. Railroad signal maintainers are experienced in preventive maintenance and trouble-shooting of relay equipment but they have had little or no experience with electronic apparatus. For these reasons careful consideration was necessary before an electronic system could be offered to supplant all-relay systems.

Cold-cathode tubes have several features which recommend them as substitutes for relays, namely:

1. No heater energy requirement.
2. No heater burnout.
3. No energy consumption and no deterioration while not conducting.
4. Long life.
5. Visible glow while conducting.

The fact that there is no heater gives obvious advantages in power economy and reliability. The visible glow is a distinct advantage in maintenance. Maintenance of relay systems can usually be accomplished by visual inspection and the use of simple instruments such as d-c voltmeters. Cold-cathode equipment can be checked in the same manner because the tubes exhibit two distinct states, glowing or not glowing, analogous to the two states, energized or de-energized, of relays. Maintenance personnel not trained in electronics can be given procedures for locating trouble by checking that the tubes glow in certain sequences. Any deviation from proper operation can generally be attributed to the failure of a particular tube or chassis, and replacement of that unit will clear the trouble. Repair of a chassis that has been replaced will require electronic test equipment at a central repair shop, or the faulty chassis can be returned to the manufacturer for service.

RAILROAD OPERATION AND ECONOMICS OF CTC

WHERE CTC IS NOT USED, train movements are governed by means of time tables and train orders, often supplemented by automatic block signals. With this method of operation, trains govern themselves to a large degree by means of their own schedules and the schedules of other trains. The movements of all trains on a division comprising 100 or more miles of railroad is under the supervision of the dispatcher. The dispatcher is dependent upon local wayside operators for information on the progress of trains and for delivery of train orders to the train crews. If an extra, or unscheduled, train is to be run, the dispatcher issues train orders which give it authority to occupy the main track and to govern its movements with respect to other trains. If something happens which makes it necessary to revise a scheduled train's program, additional orders must be issued. These orders must be delivered to the train crews prior to the time and place that a desired action is to be taken. The orders must be based upon operating predictions arrived at by

studying all operating information available at the time the orders are originated. Any unpredicted operating situation that develops in the meantime will cause a delay to all trains concerned until new orders can be issued and delivered.

Centralized traffic control provides an operator with continuously up-to-date information about the location of trains and allows him to control track switches and signals to direct train movements without depending on wayside operators.

Centralized traffic control was originally developed to expedite train movements over single track railroad. Many case histories are on record showing that installation of the system increased the traffic capacity of a section of railroad more effectively and at much lower cost than could be accomplished by double tracking.

Today, studies are being made of multiple-track railroads to show where savings can be made by removing one or more tracks and applying cTc. Some of the items involved in a cost analysis of a cTc proposal are as follows:

1. Change in capital investment for track and signal apparatus.
2. Maintenance expense of track removed.
3. Reduction of maintenance expense of track when converted from main to side track.
4. Maintenance expense of turnouts and crossovers removed.
5. Maintenance expense of signal units and auxiliary apparatus, such as switch lamps, removed.
6. Block office operator payroll savings.

A graphic train chart is made showing how the traffic for a period of several days would be handled by cTc. From this chart the following items are determined: train hours saved; locomotives saved; car days saved; high-speed stops saved (cost of fuel wasted in making stops from running speed); low-speed stops saved (cost of fuel wasted in making stops from siding entering speed); and road overtime saved.

In the case of single-track railroad, track can be removed as the result of the change to diesel motive power which has taken place in the past few years and the addition of cTc. Diesel power has generally brought about an increase in the length and tonnage of trains, resulting in fewer trains operating on a division at one time. With fewer trains, the headway between trains increases and the number of passing sidings required is reduced. When cTc is added, track switches are power operated, so it is no longer necessary for the train to stop while a crew member operates the switch by hand, pull into the siding, and stop again to pick up the crew member after he has restored the switch to its main line position. Elimination of these stops allows the train to travel farther in a given time, allowing increased spacing of sidings.

In the case of multiple-track railroad, the flexibility of operation afforded by cTc allows the removal of track. Up-to-the-moment information on the location of trains and practically instantaneous control of switches and signals allows the operator to select an unoccupied portion of track quickly, increasing track utilization and allowing removal of unused track.

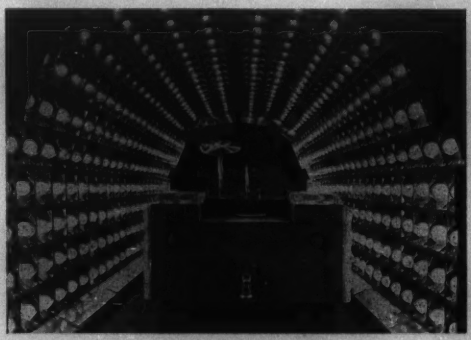
The item concerning removal of signal apparatus in the foregoing list is made possible by the increase in size and consequent reduction in number of trains, resulting in increased headway and making it no longer necessary to maintain a signal spacing which was established for close following moves. The increase in tonnage of trains has increased the braking distance, also calling for increased signal spacing.

Studies made for various railroads show annual returns on capital investment of 20 to several hundred per cent and return on total cost of 6 to 30 per cent. Several major railroads are now in the process of the converting entire divisions from multiple track to single or double track with centralized traffic control.

Infrared Oven Saves 98% of Paint-Drying Time

Ten minutes after being sprayed, Allis-Chalmers Manufacturing Company lift trucks and tractors are ready for delivery, thoroughly dried by infrared heat in a new automatic radiant oven. Air-drying the painted trucks formerly took from 8 to 48 hours at the company's Harvey, Ill., plant, often causing a slow-down in the finishing department.

The radiant oven, manufactured by Fostoria Pressed Steel Corporation, Fostoria, Ohio, is just 18 feet 4 inches long, and equipped with *G-30* lamps having a total connected load of 100 kw. After spraying, completed trucks with gas tanks full, and minus only the seat, move through this tunnel oven for a thorough infrared paint-drying operation that takes only 10 minutes, automatically timed to the spraying job.



Field Experience with the *A2A* Video System

R. W. GAST

This newly designed video system provides high-quality local wire channels to interconnect television studios, transmitters, and other operating points. This article describes the system, showing typical applications, performance, and operating characteristics.

A NEW VIDEO TRANSMISSION SYSTEM known as *A2A* has recently been developed for use on local wire channels in television network service. The *A2A* system provides video transmission for frequencies up to 4.5 mc and to distances of approximately 10 miles over balanced cable pairs designed for the purpose. This article describes the system from a field point of view showing typical applications, performance, and operating considerations.

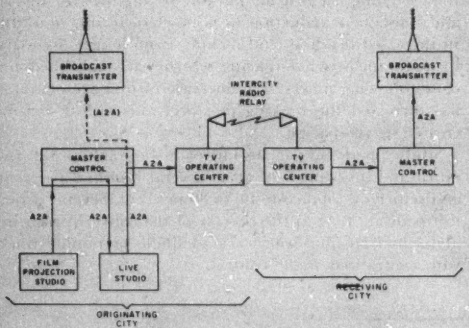


Fig. 1. Connections for typical network telecast.

The first *A2A* system was installed for field trial in July 1954, and underwent tests for a period of 10 months. This was prototype equipment. Commercial service was initiated with production-type equipment in New York City in September 1955, on one studio-transmitter line, followed by eight network connecting lines in October and November of the same year. Since then substantial amounts of *A2A* have been installed in various cities to provide for growth and to facilitate maintenance of critical lines.

The local video channel forms an important part of the closed-circuit network as used for television broadcasting. *A2A* design is predicated on meeting high-quality performance objectives for an over-all 4,000-mile network which may comprise a number of local circuits along with intercity facilities.

In the early days of television broadcasting, when each station provided its own program material, a signal might originate at a field pick-up point, be transmitted to the studio over a short link, and be sent from the studio to the broadcast transmitter over another; these two links constituting the entire closed-circuit path. Now with nation-wide networks, circuits have been extended to thousands of miles in length with complex intercity and local facilities operating in tandem. The transmission quality expected on a coast-to-coast circuit excels that which may have been acceptable on the local loops alone a few years ago. Introduction of color has added further exacting transmission requirements to those for black and white. Local video channels constitute only a small part of the network circuit mileage, but they form important and critical links in the over-all system. As an illustration, Fig. 1 shows the circuits for a typical network telecast in simplified form. In this particular instance, six local circuits are connected in tandem with the intercity facilities. Most network programs will involve at least three local circuits at the sending end and two at the receiving end.

The make-up of a television network varies from hour to hour according to program demands, and it is not possible to line up or equalize the network on an over-all basis. Each link must be capable of a transmission quality such that when all the necessary links are connected in tandem, the picture will not be appreciably degraded.

DESIGN CONSIDERATIONS

THE SYSTEM is designed to use the shielded cable pairs which have been placed extensively for video use in the telephone plant since 1947. Each balanced video pair consists of two 16-gage wires, polyethylene insulated, and enclosed in a double shield of copper tape. Several versions of video pair have been manufactured, differing slightly in construction but similar in electrical characteristics. The *A2A* system may employ any of these shielded video pairs, but it is not designed for use with ordinary paper insulated telephone pairs which have been employed for video to a limited extent in the past.

The circuit lengths over which *A2A* must operate

Full text of paper 56-972, "Field Experience with the *A2A* Video System," recommended by the AIEE Committee on Television and Aural Broadcasting Systems and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meetings, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Communication and Electronics*, 1956.

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depend on the physical locations of studios and other terminating points, as well as the locations of telephone buildings which can accommodate repeaters and the available cable routes. In a city, an erratic pattern of terminal and repeater locations is to be expected.

The circuit lengths range from a fraction of a mile to about 10 miles; the majority being one or two miles long. In a large active television center such as New York, local circuits are rearranged, and connected and disconnected with surprising frequency to meet the day-to-day needs of broadcasters and industrial users. Studios, many of which are in leased buildings, may be moved and sometimes change hands from one broadcasting company to another. In addition, there are unpredictable demands for one-time pick-up and closed-circuit networks. These requirements are anticipated in the *A2A* system by a variety of amplifiers and cable equalizers, which may be assembled in a number of combinations. Portable equipment is available for temporary installations. Both the portable and the rack-mounted equipment is arranged for flexible assignment with cable sections of any length up to the working limit.

Fig. 2 shows a simplified block diagram of a single-link *A2A* circuit, where there is approximately 1 mile of cable between the transmitting terminal and the receiving terminal. The circuit is of unity gain with an input of 1 volt peak-to-peak for the composite video signal. The transmitting terminal consists of a cable equalizer, which introduces low-frequency loss complimentary to the high-frequency loss of a portion of the cable. This is followed by an output amplifier, which supplies gain and converts the 75-ohm unbalanced input to a balanced output, the impedance of which matches closely the characteristic impedance of the cable pair. The transmitting terminal has several functions. It effectively isolates the cable pair from the studio equipment and provides a near-perfect termination for the input signal. Thus, it is possible to monitor the signal at the input terminal by means of a very-high-impedance monitoring probe. Second, the pre-equalization at the transmitting end of the circuit causes high-frequency components to be transmitted at high level to overcome the cable attenuation losses while the low-frequency components, which are attenuated a lesser amount by the cable, are reduced to a lower level to prevent excessive modulation or overloading in the amplifiers.

At the receiving terminal, the input amplifier again terminates the balanced cable pair, matching its impedance over the entire video band, down to very low frequencies. With impedance matching at both ends of the cable, the effects of reflection and interaction are eliminated. Consequently, it is necessary to equalize only for the true loss characteristic of the line, and the equalizer units can be provided in various sizes to correct for measured lengths of cable.

The input amplifier has a 75-ohm output impedance. All of the remaining equipment in the receiving terminal is interconnected at this impedance. Beyond the input amplifier, the receiving terminal consists of one or more fixed cable equalizers with associated amplifiers, a group

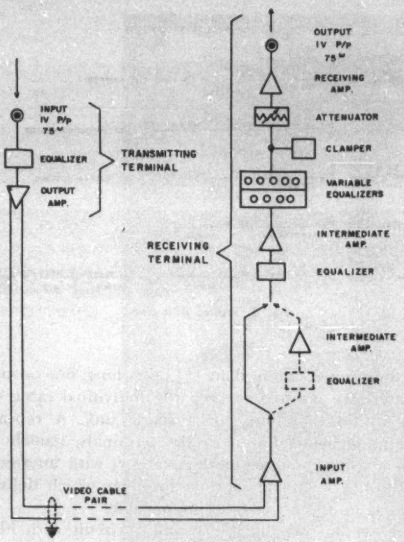

Fig. 2. Block schematic of single link circuit.

of variable equalizers for fine adjustments, and a receiving amplifier which delivers the 1-volt output signal.

A clamper operates in shunt with the 75-ohm path within the receiving terminal, as shown in the block diagram. It samples the crest level of each sync pulse of video signal and feeds back at the bridging point a signal, which substantially cancels any low-frequency interference or distortion which may have been superimposed during transmission.

The various amplifiers in the system are operated at fixed gains. Small adjustments in the operating level are made by means of an attenuator which is calibrated in 0.5-db steps.

The terminals diagramed in Fig. 2 show unbalanced connections of 75-ohm coaxial type for interconnection with the facilities of broadcasters and industrial users. Optionally these terminals may be arranged for 2-wire balanced connections at 124-ohm impedance. The balanced arrangement is generally used by the telephone company at its own points of interconnection.

A nonrepeatered circuit arranged, as shown, with flat amplifiers is useful up to about 3.2 miles of cable length. This distance may be increased by substituting other output amplifiers and input amplifiers. The increased range is obtained through an amplifier-to-line network which embodies transformer action over the upper part of the 4.5-mc band. The transformer coupling increases the high-frequency gain in order to overcome losses of the longer cable pair. In practice, the range is increased to about 3.8 miles by substituting the output amplifier with one of the network type. For a still longer cable, the input amplifier also is changed to one of network type.

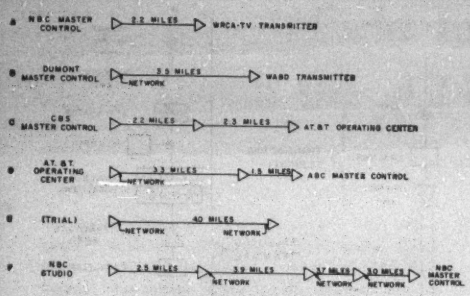

Fig. 3. Typical *A2A* lines.

If the circuit is more than 4¼ miles long, one or more repeaters are inserted to keep the individual cable sections within the limits for a single link. A repeater contains elements found in the terminals, namely an input amplifier, one or more equalizers with intermediate amplifiers, and an output amplifier which delivers the signal to the succeeding link of cable.

It is seldom possible to lay out a circuit with ideal repeater spacings because of the physical conditions encountered such as the location of buildings. A practical advantage of *A2A* is its adaptability to irregular repeater spacings and to various cable lengths. The need for this is evident in Fig. 3 which shows examples of actual lines in New York City. *A* and *B* are single link circuits. Line *A* uses the flat amplifiers which have been described. Line *B*, due to its greater length, requires one network-type amplifier at the sending end. Examples *C* and *D* are lines requiring one repeater, and of identical length. The unequal repeater spacing in *D* makes necessary a network-type amplifier for the first cable section. *E* illustrates a 4-mile link which may be operated without a repeater, provided two network-type amplifiers are employed, one at each end of the cable. All of these lines have been field tested successfully and the first four are in commercial service.

An exceptionally long *A2A* line is diagramed in Example *F*, this being one of the circuits from a color studio in Brooklyn, N. Y. Theoretically, this line could be designed with only two repeaters instead of three, but here again ideal repeater spacings are not possible. Two of the cable sections are long enough to warrant use of network-type input amplifiers, but the equipment shown was selected for the sake of simplicity. There are lines

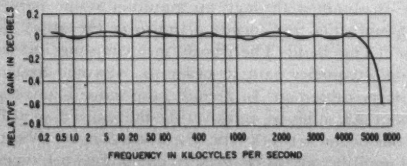

Fig. 4. Over-all gain characteristic of typical 5-mile circuit.

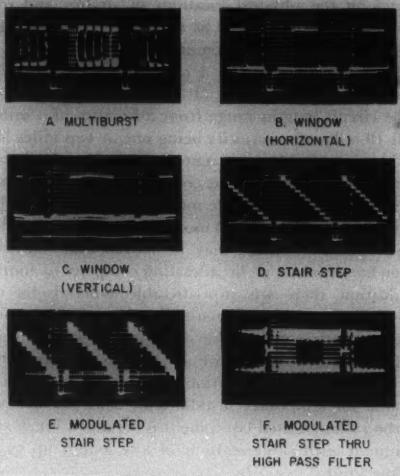

Fig. 5. Test signals over *A2A*, 9 circuit miles.

operating in each direction along this route and similar repeaters are employed in all of the circuits.

PERFORMANCE

THE ORIGINAL FIELD TRIAL CIRCUIT, 5 miles long with one repeater, was tested over a period of 10 months and confirmed that the design objectives for the system had been realized. After the first commercial circuits were installed on network connections to the American Telephone and Telegraph Company (AT&T) Television Operating Center in New York and on a studio-transmitter line, their performance was watched critically by the broadcasters and by the telephone company. Aside from a few minor difficulties at first, which were traced to faulty components, the performance of these lines in regular service has been most satisfactory, confirming the results of the earlier tests.

The measured over-all gain-vs-frequency characteristic for a representative 5-mile circuit is given in Fig. 4. The residual gain ripples are less than ±0.04 db up to about 4.8 mc. Above this frequency, the response rolls off gradually with the 6-db point at about 7 mc. This particular data was taken with laboratory type test equipment capable of indicating a difference of 1/100 db.

The low-frequency response is plotted down to only 300 cycles. If this curve were extended it would show uniform response down to frequencies below 60 cps. In the *A2A* system, there are no line transformers which could introduce low-frequency distortion.

As mentioned previously, fixed cable equalizers are available in discrete sizes to handle circuits of a variety of lengths. In equalizing a line, values of fixed equalizers are chosen so that the gain at 4.5 mc is brought within ±1.25 db of the low-frequency gain. Precise equalization is accomplished by manually adjusting a group of vari-

able equalizers at the receiving terminal. In this operation, gain is measured relative to that at a reference frequency of 300 kc, this being done at nine specified frequencies while the appropriate equalizers are adjusted. The residual slope across the band is first corrected by setting a cable-shaped equalizer, so that the gain at 4.5 mc equals that at the low reference frequency. Next, the very-low-frequency region is adjusted and finally minor deviations within the band are corrected by means of a number of variable equalizers of proper shapes. Altogether by this procedure 10 points in the video band are adjusted to precisely the same relative gain. If the cable sections are long, four additional adjustments are provided, making 13 frequency points which may be set precisely. With this equalization method, an initial cable distortion of 100 or more db may be reduced to less than 0.05 db. The range of adjustment in the variable equalizers is sufficient to correct deviations on lines up to 6½ miles long (120 db of cable slope), with margin for periodic readjustments. On extremely long lines, a second set of variable equalizers is usually added. Such is the case for the 13-mile line mentioned before, which involved an over-all cable loss of 238 db at 4.5 mc, corrected by equalization.

The system has proved to be stable in frequency-gain characteristic, the only significant change over a period of time being attributed to the effect of temperature on attenuation of the video cable. With most of the cable underground this change is a gradual seasonal effect which lags a month or more behind the outside temperature. Based on measurements made over an extended period, the average rate of slope change is approximately 0.15 db per week for a 5-mile line.

Each fixed cable loss equalizer has associated with it a corresponding phase equalizer for correcting the phase distortion in the related length of line. With the appropriate phase equalization associated with each loss equalizer, it is unnecessary to make phase measurements or adjustments in the field. In the case of the variable equalizers, no phase correction is necessary. Not only is their phase distortion small, but their characteristics above 4.5 mc are such that their phase tends to be complimentary to the characteristics being equalized.

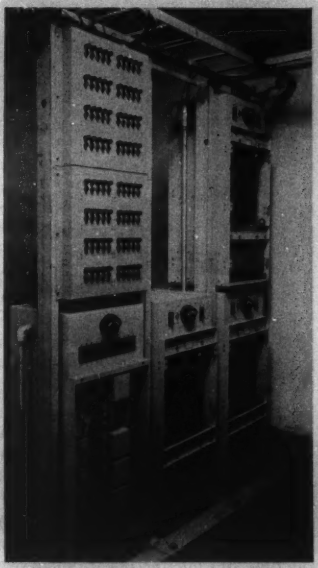

Fig. 7. Common 200-volt d-c power supply (covers removed).

Fig. 6. Typical A2A terminals.

Fig. 5 shows test signals photographed after transmission over two 4½-mile circuits in tandem. These are the familiar multiburst, window, and stair-step wave forms from a Telechrome portable signal generator.[1] Signals like these are not used for making adjustments in the *A2A* system, but they are convenient for rapidly checking the over-all quality of transmission through the various facilities involved for a network television program.

It is essential, of course, that the oscilloscopes used at various points be alike in performance for wave form tests to be significant. In this instance, a single high-quality scope was used, first to set up the signals and then to observe them over the looped circuits under test. An *A2A* line in normal adjustment will introduce no appreciable change in the multiburst presentation, either as to the relative amplitudes of the white flag and sine-wave bursts or as to their symmetry. A pronounced change in the proportions of the test signal would indicate a probable trouble condition, either in the transmission path or in the test equipment. The effect of various forms of distortion on these test signals has been described elsewhere[2] and will not be covered in detail.

The window signal square wave should show no appreciable tilt or displacement, these being evidences of low-frequency distortion which can cause picture streaking. The *A2A* system shows very good low-frequency response and stability.

High-frequency ringing, if present, would be evident at sudden transitions from black to white or vice versa,

Fig. 8. Typical test equipment.

where the transients would show on the window signal. When first placed in service, *A2A* was thought to introduce perceptible ringing at frequencies between 4.0 mc and 4.5 mc. This was inconsistent with the design theory, and was not supported by subsequent tests. It was found, however, that if the test signal has an abnormally fast rise time (0.1 microsecond), a small overshoot will appear on the square wave after transmission over *A2A*. This will be observed only on a wide-band oscilloscope. The effect is produced above the normal transmission band at a frequency of approximately 5 mc and apparently is due to the phase characteristic in the cut-off region. In the *A2A* system, phase equalization is not carried above 4.5 mc inasmuch as the higher frequencies are filtered out by television broadcasting transmitters and thus do not effect home receivers. The spiking effect may be minimized by proper adjustment of rise time in the test signal generator and sync generator.

Differential gain (as checked by the modulated stair-step signal) and differential phase are of special interest because of their effect on the color subcarrier in the National Television System Committee (NTSC) color system. The amount of differential gain and phase is dependent on the number of amplifiers used in each circuit, but does not necessarily add arithmetically when units are placed in tandem. Measurements taken with the *47A* transmission measuring set[8] show that on a typical *A2A* circuit, differential phase is 0.2 degree or less, and differential gain of about 0.2 db may be expected, for the maximum signal voltage excursion. Measured on a voltage basis, by the modulated stair-step method, the differential gain is less than 5 per cent white expansion. These values are small fractions of the allowable differential phase and gain, from camera to receiver, in the NTSC system.

SIGNAL TO NOISE

NOISE OBJECTIVES for *A2A* contemplate, as in other aspects of performance, that the local circuit is part of the tandem network connection. By design, the *A2A* line must have a better signal-to-noise margin than is accepted as satisfactory for the over-all network. The effect of random noise on a picture depends on the spectral distribution of the noise across the video band. With appropriate weightings for this spectral effect, the accepted objective for a long network is about 54 db[4] at present. This is in terms of peak-to-peak signal to weighted rms noise. It includes requirements imposed by color, which are somewhat more severe than monochrome. Considering the number and length of local circuits which may be involved, an objective of 65 db was taken as desirable for one local circuit. This is the design figure which determines the allowable length of cable sections in the *A2A* system. Field measurements of weighted random noise are in good agreement with the computed performance.

In field operations, this type of weighted noise measurement is not commonly made. Noise is usually judged by visual observation of picture or by checking the video wave form for thickening of base lines in the blanking interval. Indication of noise by the oscilloscope method depends on the characteristic of the instrument used. For example, a wide-band oscilloscope with flat response exaggerates the effect of noise, because it lacks the frequency weighting and also displays noise effects which are outside of the video band.

The *A2A* video system contains numerous safeguards against extraneous noise. Among these are balanced line transmission, elaborate shielding, and shock mounting of amplifier panels, to mention only a few. Wire video transmission, by its very nature, involves the amplification of weak signals at the end of long sections of cable, where the higher frequencies have been attenuated as much as 67 db below 1 volt. Amplifiers handling these low-level signals are susceptible to outside disturbances and require that certain precautions be taken. Noise problems may be avoided by installing the equipment so that: (1) it is not subjected to abnormal mechanical

Fig. 9. Jack fields and test positions.

vibration, (2) it is not subjected to abnormal acoustical noise, and (3) it is separated a safe distance from possible sources of electrical disturbance. The latter include electrical equipment containing make-and-break contacts, such as signaling devices, relays, and switches. Normal precautions are also required to bond and ground equipment frameworks and to eliminate differences of potential between the *A2A* ground, the power line neutral, and the ground used for studio equipment.

TYPICAL INSTALLATIONS

IT MAY BE OF INTEREST to look at typical *A2A* equipment from the point of view of one planning new installations or having to operate the system. Fig. 6 shows a typical group of terminals, as installed at a studio location. The racks are of self-supporting type, 7 feet high with 19-inch equipment panels. Wiring is enclosed in the vertical rack members, which are of duct construction. *A2A* equipment is specially designed for duct-type racks and, generally, it is not practical to mount the panels on other types of framework. In this illustration, the two left-hand bays contain power regulator and alarm panels, as well as rectifier units of selenium type. The third bay contains six transmitting terminals. At the right are six receiving terminals, two per bay. These facilities should be located within 100 or 200 feet of the broadcaster's jack panel with which they are connected by means of flexible coaxial cables. Room for telephone company equipment may be determined in the early stages of planning for new studios. In established locations, where space is usually at a premium, considerable ingenuity may be called for on the part of the broadcaster and the telephone company to find a suitable location which meets operating requirements.

A2A terminals are also available in portable cabinets. These are convenient when the service is of temporary nature or where only one or two lines are involved.

The *A2A* system employs small rectifier units which, in general, supply plate power to an individual receiving terminal, an individual repeater, or up to four transmitting terminals. For locations where there is a large concentration of equipment, use is made of a Flotrol power supply, such as illustrated in Fig. 7 with cover panels removed. This unit has a capacity of 15 amperes at 200 volts with provision to increase the capacity to 22.5 amperes by adding another rectifier section. A 15-ampere unit will supply power to a total of 22 transmitting terminals and 22 full-size receiving terminals. With a common power supply, a saving is realized in cost and in the floor space occupied. Precautions have been taken in the design to minimize the chance of a service interruption. Should one rectifier unit fail, lose its a-c supply, or require servicing, the remaining units will carry the full load without interruption. In a similar manner, sections of the filter capacitor are protected individually and may be replaced while the unit remains in service.

An elaborate array of precision test equipment is provided for circuit line-up, equalization, and maintenance. Some of the typical gear is shown in Fig. 8. This illustrates the need for adequate working space around the terminals. All of the testing is done preferably right at the terminal equipment. Allowance is made for the short coaxial cable to the studio termination, by substituting an equivalent loop of the same cable during the tests.

The last photograph (Fig. 9) was taken at a large *A2A* installation in a telephone building to show the central jack fields and test positions. Here, the high ceilings permit use of 11-foot 6-inch racks. The video cables terminate at the top of the bays where the pairs are connected by flexible patch cords to the assigned equipment. Secondary jacks are placed at working level. Here circuits may be monitored and in the event of trouble, emergency units may be patched in. The telephone key and lamp panels form part of a communications system which connects with other video locations throughout the city. Some of the test equipment is rack-mounted; the remainder, not shown, being in portable form. This particular installation provides terminals for 36 *A2A* circuits serving the New York AT&T Television Operating Center.

CONCLUSION

THE *A2A* VIDEO SYSTEM fills a need for a high-quality local wire facility to interconnect television studios, transmitters, and other operating points. It transmits standard composite signals at video frequencies for distances up to about 10 miles over shielded low-loss cable pairs provided for the purpose in the telephone plant. Unit construction of amplifiers and cable equalizers adapts the system for flexible operation with circuits of various lengths and with irregular repeater spacing. Transmission quality is such that several *A2A* lines may be connected in tandem with intercity facilities in normal network operation.

Once the video cables and *A2A* equipment have been installed, circuit lineup is straightforward and rapid, and lines can be rearranged readily to meet changing service demands. Careful planning of *A2A* facilities with particular emphasis on good working space and proper location will facilitate maintenance and assure optimum performance of the system.

ACKNOWLEDGMENT

MANY PERSONS participated in the installation and testing of the first *A2A* systems and contributed valuable suggestions which the author would like to acknowledge individually, if this were possible. These include associates in the New York Telephone Company, the Bell Telephone Laboratories, and the AT&T; also, H. C. Gronberg of the National Broadcasting Company, and W. F. Whalley of the Columbia Broadcasting System, who participated in many tests.

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What the Technical Reader Expects of the Scientist and Engineer Who Write

EVERETT S. LEE
FELLOW AIEE

In an address presented primarily to technical writers and editors, the editor of a well-known technical publication stresses the importance of the effective dissemination of ideas in the fields of engineering and science.

WHENEVER I think of the writings of the scientist and the engineer, I recall the experience told me by a news reporter on a prominent New York daily. He had dropped into a meeting of engineers in the auditorium of the Engineering Societies Building on West 39th Street in New York City. He said he couldn't understand what the engineer speaking from the platform was saying, nor could he understand what the engineer had written when he read his paper.

And so indeed he couldn't understand him—for the engineer writes for his fellow engineers and the scientist writes for his fellow scientists. And therein we have one of the golden keys which unlocks the road to advancement in new knowledge, and in new understanding, and in the progress which has brought to the people of our land the highest standard of living known to man.

THE PROCESS OF COMMUNICATION

As the scientist brings forth new knowledge from nature he documents his discoveries and his findings for others to read and to consider in their work. The engineer, taking that new knowledge, fashions it into products for the people to have and to use. Then he writes of his findings, his experiences, and his accomplishments for his colleagues to read and to absorb.

This process of communication through the years has provided the scientist and the engineer with the outlet for inspiration and with the understanding for progress which has undergirded our advancements and our prosperity. No one can visualize the extent of its scope nor the vastness of its power. Take it away and progress would stop. This communication process permeates the whole of the advancement in our conquest of nature and in our improvement in the welfare of man.

The meetings of the engineer and the scientist extend beyond every measure. Recently, in the morning mail, I received the programs of two engineering meetings in Chicago, Ill. One was the Fall General Meeting of the American Institute of Electrical Engineers. The other was the National Electronics Conference and Exhibition.

The program of the AIEE meeting included 144 papers covering many of the wealth of subjects in the fascinating realm of electrical engineering, including rotating machinery, protective devices, metallic rectifiers, land transportation, safety, transformers, conductors for industrial systems, television and aural broadcasting, insulated conductors, chemical industry, basic sciences, management, telegraph systems, mining and metal industry, feedback control systems, communication theory, automation, switchgear, system engineering, ethics, radio communication, wire communication systems, the science of materials in electrical engineering practice, transmission and distribution, communication maintenance, power generation, and industrial control, together with a seminar on education in electronics, and all highlighted by a testimonial gathering in honor of that great engineer Nikola Tesla, and a luncheon to celebrate the 80th birthday of another great engineer, Dr. Charles F. Kettering.

And while the words of wisdom on these multitudinous subjects were scheduled to be flowing from the engineers and scientists in the Morrison Hotel as they presented their written papers, the National Electronics Conference and Exhibition was scheduled to be in session at the Hotel Sherman. Here the program listed 92 papers in the intriguing field of electronics, including the subjects of components and materials, instrumentation, servomechanism applications, measurements, receiver techniques, data-storage systems, servomechanism theory, application of information theory, magnetic amplifiers, solid-state devices and application, network and filter theory, radioisotopes, data-processing systems, microwaves, high-power audio systems, network synthesis, antennas, quality control and reliability, automation techniques, medical electronics, and pulse techniques, all highlighted by luncheons and addresses, and exhibits of the newest of products and techniques.

The 236 papers written for presentation at these two meetings will be largely unintelligible to the 165 million Americans who will benefit from them in better electrical living. And yet these papers are a motivating force to progress for the engineers and scientists whose contributions have made these meetings possible as well as their associates who will attend to gain knowledge and inspiration from their presentations as new frontiers are opened and old horizons extended. In addition, they will be printed and circulated in the society publications for availability throughout the years.

Essentially full text of an address presented at the annual convention of The Association of Technical Writers and Editors, and Society of Technical Writers at the Hotel Statler, New York, N. Y., November 15, 1956.

Everett S. Lee, past president AIEE (1948-49), is past editor of the *General Electric Review*, General Electric Company, Schenectady, N. Y.

Meetings such as these go on week after week, month after month, year after year, throughout the many great engineering and scientific societies of our land. For these societies were founded largely to provide just such forums for the presentation and discussion of scientific and engineering knowledge and its dissemination to the uttermost parts of the world. That is what the engineers and scientists in that great group of technical readers expect of the scientist and the engineer who write—and that is what they get.

In January of 1956, the program of the AIEE Winter General Meeting listed 440 engineering and scientific papers. In November, the American Society of Mechanical Engineers will hold its 1956 Annual Meeting, and the program will include 249 engineering papers.

Need I say more? You get the picture. The approximately 900,000 engineers and scientists in our land are telling their associates what they have found out or what they are doing. Even though their writings may be unintelligible to the other millions of people of our land, nevertheless, out of the work of which they write come our products for progress and the pursuit of happiness. The literature the scientists and the engineers have built up over the years through their own scientific and engineering societies is a lighthouse to the peoples of the world, a magnificent tower of strength, inspiration, and helpfulness, the like of which cannot be found.

THE ROLE OF THE TECHNICAL WRITER

YOU OF THE GREAT PROFESSION of technical writers and editors who participate with your engineers and scientists in their writings can well be proud of your contributions to their outstanding work.

By and large, the engineers and the scientists prefer to write their own papers. It is good that this is so. In the first place they are the only ones who know the material of their papers. What they are writing about is theirs and theirs alone. Second, it is good that they cease from their labors long enough to look at the results of their work, to systematize it for presentation, to locate it in its proper place in the literature, and to refine it for useful results. And third, it brings to them the rare satisfaction and pride of accomplishment of telling their fellow engineers and scientists what they have done for helpfulness to others.

In their writings to their fellows, they think of their audience as their associates in their particular field. Thus technical language is justified. But not being specialists, as a rule, in the area of writing and presentation, they may well need help with the fundamentals of good writing so that what they write has unity, coherence, and emphasis. This is where you may make your contribution felt. In my experience, engineers and scientists so well appreciate the rocky road to any achievement, be it the doing of it or the writing of it, that they will want to draw on all available aids to come out in the end with a tangible result which will be a credit to them. I have read the papers of many engineers, and scientists also, in their final form, and have been inspired by them. If your sympathetic editing has been involved in the preparation of any paper, then I know that the result is enhanced manyfold. The point to be remembered, however, is that it is the engineer writing to the engineer in his field, the scientist to the scientist in his. This is fundamental.

THE TRADE MAGAZINE

NOW LET US CONSIDER that great body of writing which appears in trade magazines. These media reach into every known avenue where the products of the engineer are made and used. Here the audience is composed of those in the many respective fields who design the products, who produce the products, who sell the products, who install the products, who use the products, or who maintain the products. In this audience, the technical reader is looking for information useful to his day-in and day-out work. This embraces mostly immediate thinking and planning opportunity, but long-range planning also has its place.

It is in the realm of the literature of the trade magazine where you as professional technical writers and editors may find even greater opportunities for making valuable contributions. To take the findings of the development and design engineer and wrap them into an attractive package for a specialized group of technical readers is not in their province. That is your work. And it requires talent which is found only in the few. To grasp the opportunity in the achievement of the engineer and make it understandable and useful to the technical reader requires both an appreciation and a recognition of the reader. These you must have. Having them, you will enable the technical reader in his field to gain from his reading, quickly and concisely, just what he wants to know. Some engineers may be able to do this work, but on the whole they would rather that you did it for them, or co-operated with them in doing it. In either case they will have to take part in the production sufficiently to make the finished article something that can be considered as theirs.

You will note that in the trade magazine field I have spoken only of the engineer. The scientist may enter this field to some extent, but I am sure he would want your complete help and he would say that the article should be yours. In those magazines, however, which do principally bring to the technical reader the work of the scientist we find a most outstanding area of professional technical writing where the editorial and writer participation must be highly sympathetic to the scientist and well appreciative of the audience. And here the scientist will no doubt use his name, as he will author the original article.

THE NEWSPAPER

BEYOND THE TRADE MAGAZINE is the newspaper. To me the newspapers of our land do a most outstanding job in bringing to the technical reader an up-to-the-minute account of the latest in science and engineering. I have addressed many audiences on the subject: "What's New in Science and Engineering," and I have often said to

the audience that if they have read the newspapers, they know the answers. If you want to know the largest steam turbine electric generator on order, you will find the announcement of it in the daily press. If you want to know the fastest airplane in operation, there was an account of it and a picture of it in the daily press. And so on, covering the entire realm of technological developments.

The science editors of our daily press are known for their outstanding columns. They put the very latest of scientific discoveries and findings into language for the laymen, and yet their writing is not too elementary for the technical reader, whoever he may be. Every one of these items and articles traces back to an engineer or a scientist, or a group of engineers or scientists, since there is so much team participation in both scientific and particularly in engineering work today. Some of you of the technical writers' profession are no doubt prominent in this tracer line from the scientist and the engineer to the technical reader. In the daily newspapers the identity of the engineer and scientist may or may not be made known. But the source of the news account, no doubt, was a paper written by the engineer or scientist, or an article prepared with your greater participation. It would be good if the identity of the originating engineer or scientist could be made known for his recognition.

THE INSTRUCTION MANUAL

GOING BACK to within the workshop of the engineer, we come to the instruction book. This is definitely the technical writer's field. You are it. You must know the audience, the subject, and the appropriate details. The engineer you must know. What you write will be closely scrutinized and must be appropriately approved. And if it is produced for the United States Government it must be "according to Hoyle."

You are it. You write the instruction book. But in considering its use, remember that to the user it stands as "heaven sent." And remember, too, that the one who reads it wants to know how the machine or equipment works, how to operate it, and how to keep it working. And the reader may not be technical.

I trust you will pardon me if I add a word that has a distinct personal flavor but nevertheless definitely involves one phase of technical writing. I speak of the *General Electric Review*—a magazine I have loved ever since I helped to sell it at the University of Illinois when I was an engineering student some 45 years ago, and of which I have been privileged to be the editor for the past six years. The *Review* was always highly engineering and scientific. It was revered by its readership for that stature. But most people couldn't read it.

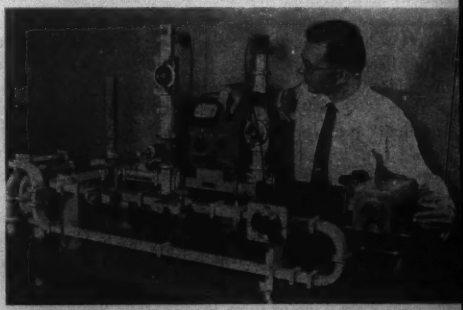
When I became editor in 1951, the paid circulation was some 8,000. My charter was to make the *Review* appropriate to the General Electric Company. We had many friends. We found that a circulation of 100,000 extended severalfold by multiple readership, would not be inappropriate to the number of our engineering and scientific friends. We adopted that number for controlled circulation.

But that number included engineers in every branch of engineering—electrical, mechanical, chemical, mining and metallurgical, civil, and all the several subdivisions of these. Among the scientists it included the fields of physics, chemistry, geology, and to some extent, biology. To make our articles helpful to such a wide and varied readership, it was imperative that they be reconstructed from their initial form. The original article of the engineer or scientist, written for his own audience, had to be adapted to apply clear across the technical board. That required unusual ability in technical rewriting. But we did it, and with our wide engineering and scientific readership continually in mind, we believe we have been successful because we constantly kept before us the maxim: "Write it so it will be helpful." Judging by the many statements of appreciation from our readers, we know we have been helpful.

In conclusion—I return to my assigned title, "What the Technical Reader Expects of the Scientist and Engineer Who Write," and I give the answer in a few words: He expects to increase his knowledge and his understanding of scientific and engineering things which may be helpful to him.

Whatever you in your great profession of technical writing and editing may do to accomplish this expectation will be your contribution to one of the greatest experiences in life—giving a helping hand to man.

Traveling-Wave Tube Check



An extensive program is under way at Bell Telephone Laboratories to develop traveling-wave amplifier tubes for communications applications. Here H. L. McDowell is shown conducting tests on an experimental tube designed to provide 5 watts output with a bandwidth of 500 mc in the 6,000-mc band.

This particular test is designed to detect and measure a certain type of nonlinearity in the tube. A 6,000-mc amplitude-modulated signal is fed to the traveling-wave tube. If nonlinearity exists, some of this amplitude modulation will be converted to phase modulation, which can then be detected in the amplified signal at the output of the traveling-wave tube.

Lightning Protection of Turbine Generators

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AT PRESENT, it is the general practice to apply lightning protective equipment at the terminals of large unit-connected generators. There is a hesitation on the part of industry to omit protective equipment, even though analysis of the problem indicates that no protection is needed. This is primarily because the cost of the added insurance or protective devices is trivial when compared with the investment in a large machine, the expense of damage to the machine, and the expense of the loss of a large unit of generating capacity.

However, considerable attention is now being given to decreasing the separation distance between the machine and transformer. In this event, a premium price is paid for the additional space requirements of the protective apparatus. Also, because of the high reliability necessary in the operation of large generators, there is justifiable reluctance to add any equipment not absolutely essential from the standpoint of continuity of service and safety. These considerations can often outweigh the arguments for applying protective devices simply because their cost is low. Therefore, there is a need for a simple straightforward procedure for determining accurately exactly when protection is necessary and when protective devices may be omitted safely.

It is the purpose of this article to develop equivalent circuits for evaluating protective requirements of unit-connected turbine generators. These equivalent circuits are verified by field tests on three generator–transformer systems of the Duquesne Light Company.

The unit-connected system consists of a Y-delta transformer bank connected on the delta side to the generator. The neutral of the high-voltage transformer windings is solidly grounded and lightning arresters are applied immediately adjacent to the high-voltage side of the transformer. The problem is to determine whether additional lightning protective equipment is needed at the terminals of the generator.

On the high-voltage side of the transformer, the magnitude of voltage applied to windings is equal to the arrester discharge voltage E_A. This voltage is composed of a surge voltage E_1 and a 60-cycle steady-state voltage. At the generator terminals the total voltage E_T is likewise composed of a surge component E_2, transferred through the transformer, and a 60-cycle component.

The transferred surge component and 60-cycle component, which are added to obtain total generator terminal voltage, can be analyzed separately. First, the equivalent circuits are derived for determining the magnitude of surge voltage appearing at the generator terminals. Later the magnitude of the 60-cycle component is determined and the two components are added.

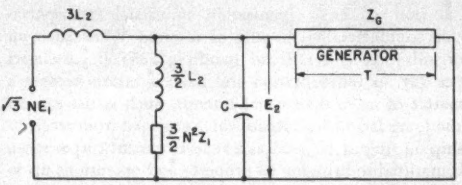

Fig. 1. Equivalent circuit for determining the surge voltage at the generator terminals for a unit-connected system. Surges arrive simultaneously on two phases on the high-voltage side of the transformer.

Fig. 1 presents the equivalent circuit for the condition of surges arriving simultaneously on two phases on the high-voltage side of the transformer, where

L_2 = Transformer leakage inductance referred to the delta side of the transformer
Z_1 = Surge impedance of line connected to the high-voltage transformer winding
Z_G = Equivalent generator surge impedance
C = Capacitance of isolated phase bus or cable connecting the generator to the transformer
T = Electrical length of generator or time required for a surge to travel from the generator terminal to the generator neutral
N = Voltage ratio of delta side line-to-line voltage to the Y side line-to-line voltage

Knowing the value of the constants of the circuit shown in Fig. 1 and the wave shape of the voltage E_1, the crest magnitude of E_2 can be obtained as a per unit value of the crest magnitude of NE_1. The total maximum voltage at the generator terminals is

$$E_T = CNE_A + V_g\sqrt{1 + C^2 + \sqrt{3}C}$$

where

E_T = Total maximum generator terminal voltage
V_g = Crest magnitude of the normal line-to-neutral voltage on the low-voltage side of the transformer
$C = \frac{E_2}{NE_1}$ as obtained from Fig. 1

The first term of the equation is the surge voltage and the second term is the 60-cycle voltage. Comparing the voltage E_T with the impulse strength of the generator determines the protective requirements of the generator.

The surge voltages at the generator terminals as obtained from the derived equivalent circuit agrees closely with the voltages measured in the field. Therefore, it is concluded that equivalent circuits can be used to evaluate protective requirements of unit-connected systems.

Digest of paper 56-973, "Lightning Protection of Unit-Connected Turbine Generators—Field and Laboratory Studies," recommended by the AIEE Committee on Protective Devices and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Modernization of the LIRR Passenger Car Fleet

P. H. HATCH

FELLOW AIEE

THE REHABILITATION and the modernization of any organization—industrial, transportation, commercial—is usually of interest. When such an organization is a railroad handling 285,000 passengers per day, its rehabilitation and modernization become a matter of more than usual interest. Such is the case of the Long Island Rail Road which emerged from receivership on August 12, 1954 as a redevelopment corporation, committed to bringing its property and operations up to modern standards.

Its car ownership consisted of 1,321 cars of which only a very small number could make any claim to being modern. Hence the rehabilitation of this fleet was first on the list of projects to be undertaken.

The rehabilitation consisted of two equally important parts: (1) the ordering of 220 new cars (not counting two Budd Company rail diesel cars) and (2) the modernizing of 696 of the existing cars. In the interests of standardization and economy, the two parts of the project were related as closely as practicable and higher seating capacity in both new and modernized cars was decided upon to facilitate terminal and other problems.

After careful consideration of double-deck, gallery, and single-deck cars, the latter type was selected and an order was placed for 220 cars, 80 for locomotive train service and 140 for multiple-unit electric service, basic car structures and arrangements being the same for all 220.

Electric power supply for the 80 new cars for locomotive-hauled trains presented a major problem because of short runs and frequent stops. The conventional axle-driven generator–storage-battery combination was not adequate under these conditions. Therefore, a 25-kw 220-volt 3-phase 60-cycle diesel-engine-driven alternator set was placed under each car for independent power supply.

The old multiple-unit car fleet consisted of motor cars and trailers. Practically all of the motor cars had 2-motor equipments, one truck being a motor truck and the other a trailer truck. It was necessary for economic reasons to continue the motor and trailer car setup but all the new motor cars had 4-motor equipments in order to take advantage of all available adhesion weight; operating results to date have justified this move. Control was arranged so the new cars would multiple with the old. Dynamic braking was omitted on account of this and trailer car operation.

Other design improvements included a standard, short, equalizer-mounted third-rail shoe beam; high-capacity line circuit breaker; thermostatic heat control; high-speed traction motor gearing; and mounting of traction motors entirely on truck frames. Of equal importance with acquisition of new cars was the modernization of a total of 696 existing cars, this total consisting of 217 locomotive-hauled cars and 479 multiple-unit cars.

Cars to be modernized were stripped down to the bare structures. Necessary repairs and reinforcements were made to car bodies, and trucks were completely dismantled and overhauled. Interiors were modified and fitted so that the general appearance is the same as that of the new cars.

The principal differences were the use of high-intensity incandescent lighting in place of fluorescent, and paddle-type fans for air circulation instead of air conditioning.

Electric propulsion equipment on existing cars was for the most part somewhat antiquated, with high maintenance and mediocre performance records. A program was undertaken, therefore, of upgrading traction motor insulation, installing roller armature bearings and all-weather covers on a number of these motors, revising commutating poles on certain motors, reapportioning accelerating resistance steps, and generally overhauling electrical equipment and wiring.

Another most important item in this program was the replacement of the line circuit breakers, which had been responsible for many road delays and much repair expense, with new type, high-capacity breakers capable of interrupting without damage a short circuit in excess of 30,000 amperes directly adjacent to a high-capacity substation.

Last, but by no means least, in the program of purchase of new cars and rehabilitation and modernization of old cars have been the provisions for adequate supporting maintenance facilities.

The principal projects included which were related to cars were a modern wheel shop with up-to-date machinery, rearrangement of shop areas and installation of new equipment for traction motor and generator repairs, a wheel grinder to recondition wheels without removal from the cars, new testing apparatus, and a thoroughly modern multiple-unit-car inspection shop.

In conclusion, the modernization of the passenger car fleet is not the entire story of the modernization of the Long Island. Dollar-wise, however, and from the standpoint of impact on the public, it is the most important single segment of the entire program. Thus, it is especially gratifying to note the favorable response to the new cars and to the rebuilt older cars.

Consequently, everything possible is being done to expedite the work so that the railroad's passenger car fleet as a whole will be brought up to the requirements of the new Long Island Rail Road.

Digest of paper 56-979, "Modernization of the Long Island Rail Road Passenger Car Fleet," recommended by the AIEE Committee on Land Transportation and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

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An Electric Speed-Torque Testing Device

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THE SPEED–TORQUE CHARACTERISTICS of a motor are established by the design parameters and the quality of the motor components. The speed–torque curve can be used to detect bad design factors and defective construction of a motor. Improper rotor heat treatment, wrong skew, poor slot combination, erratic switching of single-phase motors, and similar conditions are factors which can be recognized. To obtain speed–torque curves by means of a load test, point by point, is tedious, expensive, and not always sufficiently revealing.

A motor can be coupled to an electric speed–torque tester and a complete speed–torque curve traced on an oscilloscope in a matter of seconds. The resulting trace can be calibrated or compared with a standard trace, thus permitting quick evaluation of the subject motor.

The electric speed–torque tester consists of speed–torque unit, flywheel, and coupling assembly. To facilitate the coupling of test motors, a disk-type coupling is used which permits some misalignment of the units. However, it is very rigid in the rotational plane. A flywheel is introduced into the system in order to reduce acceleration to the point where the speed–torque curve is representative of steady-state values. It may be mounted on either the motor or the unit, as shown in Fig. 1.

A filter is used on the torque signal output to attenuate high-frequency oscillations caused by vibration and electrical interference. Also it serves to average the double-frequency torque pulsations in single-phase motors. On the speed signal a small capacitor on the rectifier output filters the ripple. Fig. 2 shows the electrical layout.

Calibration is accomplished by imposing a fixed known torque on the unit and motor when running; when de-energized, the motor and unit uniformly decelerate. By accounting for the friction and windage and eddy current drag, a calibrating value results which can be applied to the speed–torque curve.

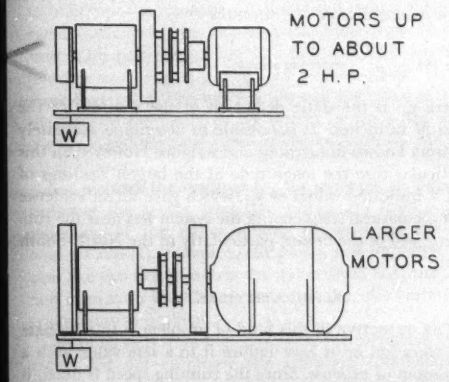

Fig. 1. General layout.

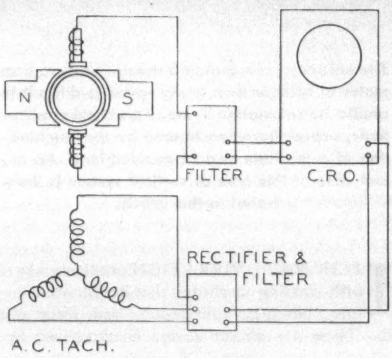

Fig. 2. Electrical layout.

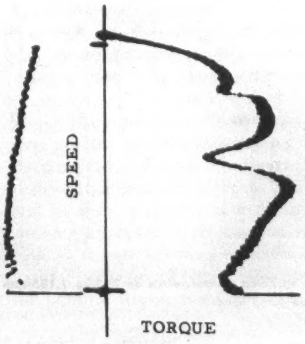

Fig. 3. Speed-torque curve, ½-hp, 2-pole, single-phase motor, 230-volt connection. Calibrating torque trace shows demagnetizing effect of current induced by the cross flux.

An oscillogram can illustrate many of the characteristics of motors which the speed–torque tester can reveal. Fig. 3 shows a motor with a deep second-harmonic cusp caused by unequal current in the main pole windings.

The device is capable of indicating a speed–torque curve with satisfactory accuracy for production testing. Torque scales can be ascertained for given models, and lower limits can be established which can be used for gaging acceptance or rejection on a visual basis.

Digest of paper 56-944, "An Electric Speed-Torque Device Based on Magnetic Principles," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 1-5, 1956. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1956.

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Vibratory Systems in Vertical-Motor Mountings

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The existence of resonant frequency in a vertical motor at or near its running speed is difficult to predict by calculation in many practical applications, especially when formed by the combination of a machine and its coupled load. An actual case of this type of vertical system is illustrated in this article.

MECHANICAL VIBRATION problems may occur with rotating machines, despite attention to balance, bearings, lubrication, and rotor critical speeds. These are almost always characterized by the existence of a resonant frequency at or near the running speed. The resonant frequency may be that of a stationary part of a single machine, or it may be formed by the combination of a machine and its coupled load or driver into a system. Cases of the latter general category, except for those involving torsional vibration from pulsating loads, are difficult to predict by calculation in many practical applications. Moreover, by their very nature they almost always occur in the field where their analysis and correction can be difficult and expensive. It is this type of case which is of interest here.

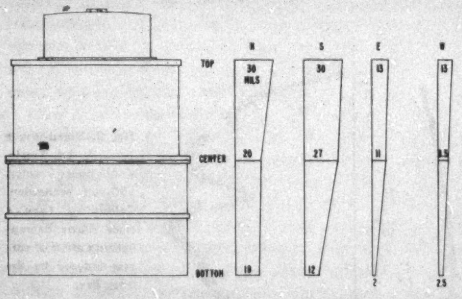

Fig. 1. Initial horizontal vibration measurements on 800-hp 1,185-rpm vertical motor mounted on pump head.

In considering the manner in which vibratory systems can be set up through mountings when a motor is coupled to its load, a vertical motor coupled to a deep-well pump offers a rather typical example. This discussion will be confined to systems with vertical shafts; however, similar phenomena can occur in horizontal machines, particularly if there are long overhangs on any portions of the stator. An actual case of a vertical system will be used for illustration.

ACTUAL CASE

A VERTICAL HOLLOW-SHAFT MOTOR rated 800 hp at 1,185 rpm, which at the factory had passed the 1-mil test floor limit for radial vibration measured on the bearing housings, was shipped to its site, mounted on the pump head and coupled to the pump. It was evident at once that the vibration was grossly excessive. Vibrometer measurements radially at the top, center, and bottom of the motor frame showed amplitudes, as given in Fig. 1.

The pump head was a cast-iron conic section, $\frac{5}{8}$ inch thick, with an upper ribbed support plate and a lower flange ring. It had two round holes, East and West, and two smaller rectangular openings, North and South, as shown in Fig. 2. The round holes, having a diameter three fourths the height of the casting, impaired the casting's ability to act as a rigid beam of annular cross section. It had different stiffnesses in the two perpendicular planes and was least rigid in the North–South plane.

Fig. 3 shows the motor and pump structure to scale and the mode of system vibration suggested by the readings of Fig. 1. Simplified to consider vibrations in one plane only, the system could be represented as a cantilever having a single degree of freedom, with the motor as the main mass M and the pump head as the spring having constant k. The natural frequency of such a system can be approximated from the formula

$$f_n = 188\sqrt{\frac{1}{y_{st}}} \quad \text{cycles per minute}$$

where y_{st} is the static deflection of the centroid of the mass M in inches.[1] It is possible to determine accurately y_{st} from known dimensions and weights. However, in this particular case the magnitude of the largest readings of Fig. 1 indicated values of y_{st}, which gave direct evidence that the natural frequency of the system was near the running speed of the motor, particularly in the North–South plane.

ELIMINATE VIBRATION

THE OBJECTIVE in this kind of problem is to eliminate the vibration or at least reduce it to a safe value with a minimum of expense. Since the running speed is fixed, it is necessary to change the natural frequency f_n. This can

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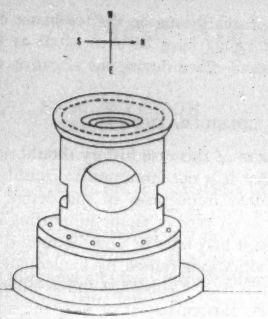

Fig. 2. Pump-head configuration.

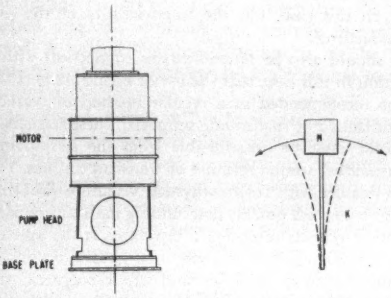

Fig. 3. Vibratory system formed by motor and pump head.

be done only by changing the mass M or the spring constant k, since

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{M}}$$

If M is large initially, changing it enough to modify f_n appreciably is usually not feasible. A more practicable approach is to work on k.

By loosening two at a time of the four bolts holding the motor to the pump head, it was found possible in this case to interrupt the resonant condftion and reduce the maximum readings in the North–South plane from 30 to 11 mils. This pointed the way to a solution to the problem, which was to install spring lock washers under each of these four bolts. The washers lowered the value of k and the natural frequency of the system to the point where the final readings were considered acceptable for the overall equipment.

Fig. 4 shows the readings for the sequence of steps: (1) isolating the motor from the pump, (2) checking the vibration of the motor alone, (3) applying the lock washers and (4) recoupling the pump. It is important in a case like this first to isolate the motor from the pump and run it on skids in order to make sure that the vibration is truly a system problem.

It can be seen from Fig. 4 (E) that the corrective action taken did not eliminate the vibration completely. In many actual vibration problems with rotating machines it is either not possible to do this or not economically justifiable. The question then arises as to how far it is necessary or desirable to go in the direction of vibration reduction.

DATA AND CHARTS

A PRACTICAL GUIDE in this respect has been given by T. C. Rathbone,[2] in the form of a chart indicating perceptory levels of vibration as a function of both amplitude and frequency. It should be noted when using Rathbone's data, however, that as he himself states, the chart is only a guide and should not be used as a source of absolute quantitative values in any particular case. Also, these recommendations are for stationary members such as pedestals and frames, and larger values are tolerable when measurements are taken on the shaft.

A comparison of the initial and final vibration conditions of this system with the tolerance curve for 1,200 rpm machines, given by Rathbone, is shown in Fig. 5. The initial vibration conditions were deep into the region considered too rough to operate for safety of equipment. Under final conditions the highest reading at the top of the motor was five times lower than under initial conditions. Although still in the "rough" category in terms of sensory perception, this magnitude of final vibration was considered reasonable and acceptable for the over-all system, and it was unnecessary to resort to any further vibration reduction measures. The motor has now been running for more than four years without trouble.

It is of interest to examine the differences in vibration amplitudes of the system caused by disconnecting the pump from the motor. Before the corrective measures were applied, the vibration was less with the pump shaft disconnected than with it connected. The reason for this is shown qualitatively in Fig. 6. The weight of the pump and its shaft, plus the down thrust of the pump when running, applies an axial compressive load P on the main mass M, thereby lowering the stiffness k and reducing the natural frequency of lateral vibrations. Conversely, when the pump is disconnected, the natural frequency of the

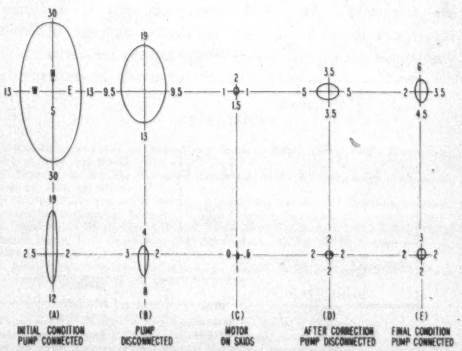

Fig. 4. Horizontal vibration measurements during steps of isolation and correction. (Top and bottom of motor frame.)

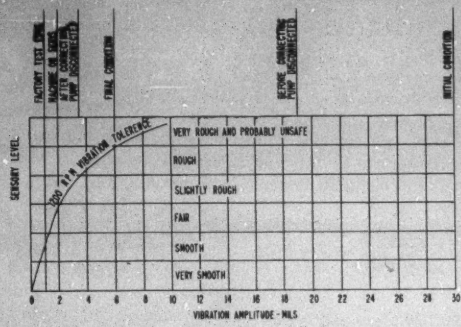

Fig. 5. System vibration conditions related to 1,200 rpm vibration tolerance characteristic of Rathbone[2].

system is raised. If, when the pump is connected, the rotational frequency f_1 is at or near the natural frequency of the system, vibration amplitude a_1 results. When the pump is disconnected the natural frequency is raised to f_2, and the exciting frequency f_1 can then only produce the lower amplitude of vibration a_2.

After application of the spring lock washers, the difference between amplitude of vibration with pump connected and disconnected was small, so its significance is questionable. From the theoretical standpoint connecting the pump should have moved the natural frequency further in the same direction as adding the lock washers and, thus, reduced the vibration even more. However, if the lock washers had already lowered the natural frequency to a point of small slope on the resonance curve, the additional effect may have been so small as to be obscured by other small effects during the vibration measurements.

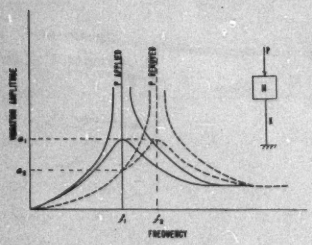

Fig. 6. Effect of removing axial load P by disconnecting pump from motor.

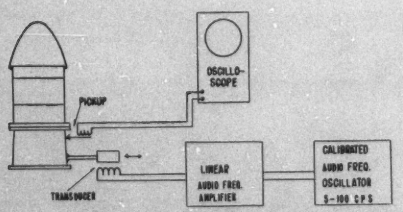

Fig. 7. Method of determining resonant frequencies of vibratory systems or components.

CONSIDERATIONS

THE CIRCUMSTANCES of this case history should not be taken to indicate that it is not important to consider the possibility of resonant frequencies in the design of a pump head or any other type of motor supporting structure, simply because it may later be possible to find some way of correcting vibrations caused by inadequate supports. The opposite is true. Knowledge and avoidance of resonant frequencies, particularly at or near the normal running speed, is an important part of the system design and, in this case, was the responsibility of the pump manufacturer.

It should also be mentioned, in connection with the solution in this case, that the use of spring washers is not to be recommended as a regular method of correcting effects caused by inadequate supports. These washers may in some cases be questionable from the standpoint of withstanding torque reaction or transient torques.

In dealing with resonant-system vibration problems a valuable tool for quickly determining natural frequencies of entire systems or system components is the apparatus shown in Fig. 7. This is a vibration generator consisting of an oscillator, amplifier and electromagnetic transducer to set up vibrations, and a magnetic pickup and oscilloscope with its amplifier used as an amplitude indicator. A resonant frequency or points for a resonance curve are found by sweeping the audio frequency oscillator through an appropriate range. With this equipment, effects of making changes in stiffness or mass on a resonant frequency can be observed while they are being made and all data can be obtained while the machine is at standstill. Varying forms of this apparatus are known as electromagnetic vibration motors and are commercially available as package equipments.

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2. Vibration Tolerance, T. C. Rathbone. *Power Plant Engineering*, Chicago, Ill., vol. 43, no. 11, November 1939, pp. 721-24.

Satellite Reference System

A satellite guidance reference system for a dozen or more proposed earth-satellite-carrying rockets has come off the pilot line at the Minneapolis-Honeywell Regulator Company. Unlike systems that require radio or radar tracking so commands can be issued to a vehicle's flight control system, the Vanguard guidance reference system is entirely rocket-borne. It will keep a finless rocket from swerving off course and generally "tip" the rocket's trajectory so it enters a globe-circling course some 300 miles above the earth.

A New Approach to Simultaneous Unbalances

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J. J. SKILES
ASSOCIATE MEMBER AIEE

I. J. NAGRATH

THE PROBLEM of analyzing simultaneous unbalances which occurs from time to time in otherwise balanced power systems has been given attention by a number of investigators. Methods of analysis which have been proposed and used include direct calculations using appropriate equations.[1, 5] Generally this approach is rather laborious for a complex system, although with the rapid advances in the use of digital computers it is to be expected that this approach will become increasingly favored. A systematic approach to setting up the basic equations and constraints for the problems has recently appeared.[2, 4]

The network calculator has been used by several investigators of this problem.[3] The chief disadvantages lie in the fact that for complete generality, including the case of unequal positive and negative sequence impedances, negative impedances or imaginary transformer turn-ratios (which imply active elements often difficult to represent) are required. With the aid of a network calculator and conventional impedances and transformers found therein, the problem may be approached directly.

A very simple and instructive method has been developed for setting up an exact equivalent circuit on the network analyzer with the extension of symmetrical components. Considering the example of Fig. 1 the conditions to be satisfied at C and D are given by the sets of equations 1, 2, 3, and 4.

These conditions can be triplicated by multiplying with 1, a, and a^2.

At fault point C

$$\begin{aligned} &I_{a1} = a^2 I_{a2} = a I_{a0} \\ &a I_{a1} = I_{a2} = a^2 I_{a0} \\ &a^2 I_{a1} = a I_{a2} = I_{a0} \end{aligned} \tag{1}$$

and

$$\begin{aligned} &V_{a1} + a^2 V_{a2} + a V_{a0} = 0 \\ &a V_{a1} + V_{a2} + a^2 V_{a0} = 0 \\ &a^2 V_{a1} + a V_{a2} + V_{a0} = 0 \end{aligned} \tag{2}$$

At fault point D

$$\begin{aligned} &I_{A1} = I_{A2} = I_{A0} \\ &a I_{A1} = a I_{A2} = a I_{A0} \\ &a^2 I_{A1} = a^2 I_{A2} = a^2 I_{A0} \end{aligned} \tag{3}$$

and

$$\begin{aligned} &V_{A1} + V_{A2} + V_{A0} = 0 \\ &a V_{A1} + a V_{A2} + a V_{A0} = 0 \\ &a^2 V_{A1} + a^2 V_{A2} + a^2 V_{A0} = 0 \end{aligned} \tag{4}$$

Instead of satisfying one set of equations at each fault point, three sets of equations are now to be satisfied. This can be done by triplicating the sequence networks in such a fashion that the three positive sequence networks have all generated voltages displaced by 0, 120 and 240 degrees, respectively.

In setting up this exact equivalent circuit on the analyzer only conventional impedances, unity-ratio isolating transformers, and generators are required. Continuous trial-and-error procedure is not required for obtaining balance and a high degree of precision can be obtained. The method is general and no such assumption as $Z_1 = Z_2$ is made herein. Effectively, it gives an analog method of solving 12 special-type simultaneous equations.

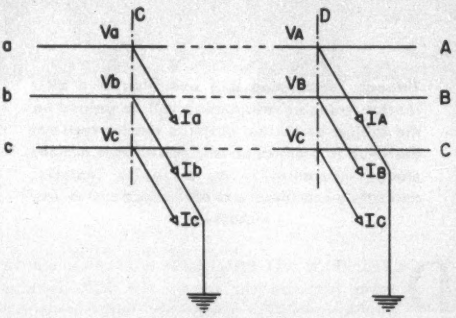

Fig. 1. Unsymmetrical simultaneous faults.

SUMMARY AND CONCLUSIONS

A NEW METHOD of studying simultaneous unbalances has been presented which requires only conventional network calculator impedances and 1-to-1 turns ratio transformers. It is applicable for all cases of simultaneous faults and open conductors with or without intervening Y-delta transformation. It is rigorously valid for the case of unequal positive and negative sequence impedances. Application of the method to a particular system problem is illustrated and the results obtained are checked against calculated results. Network calculator and calculated results agree within the possible accuracy limitations of the network calculator.

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The Sodium Graphite Reactor Electric Power Plant

SIDNEY SIEGEL

Through construction and operation of a pilot reactor, valuable information will be gained on the subject of sodium graphite reactor systems, designed to produce electric power from nuclear energy economically. The principles, features, and safety considerations of this type system are discussed.

DEVELOPED TO PRODUCE economical electric power from nuclear energy, the SGR (sodium graphite reactor) system has both immediate technical feasibility and potential for future improvement.

In mid-1954, North American Aviation, Inc., entered into a program with the U. S. Atomic Energy Commission aimed at expanding the known area of information on the SGR. This approach will be experimentally demonstrated through the construction and operation of the Sodium Reactor Experiment, a 20,000 thermal kw pilot reactor which incorporates the major design features of the full-scale SGR. An experimental engineering program with the aim of attaining the potential performance of this high-temperature, low-pressure reactor system is an important part of the joint project. This engineering development program is now under way. The Sodium Reactor Experiment will be fully operative in early 1957. Experience in construction, test, and initial operation will be available for incorporation into the initial SGR power plant, which is presently conceived to be one capable of producing 75,000 kw of net electrical power.

Among the more important features of the SGR system are the following:

1. A high coolant temperature—925 F at present; 1,200 F projected—is possible without requiring pressurization of the reactor heat transfer system. This permits good steam conditions and high thermal efficiency in the power conversion equipment.
2. The reactor scan be adapted to a variety of fuel elements and operating conditions. Both slightly enriched uranium or a Th–U-235 fuel may be used.
3. There are no chemical incompatibilities in the fuel element–coolant structure combination.
4. The absence of releasable potential energy from pressurization or chemical reactions increases the inherent safety of this reactor system and permits the plant configuration to be easily arranged to contain radioactivity under all circumstances.

The use of a liquid metal such as sodium as a heat-transfer fluid has many advantages. While solid at room temperature, it melts at 208 F and, therefore, is easy to keep liquid in a power-plant system. Sodium boils at 1,620 F, thus permitting adequately high coolant temperatures with the system at atmospheric pressure. Because liquid metals, sodium in particular, have extremely high thermal conductivity, they are excellent heat-transfer media. The fluid dynamic properties of liquid sodium are similar to those of water. A further advantage of sodium is the general absence of chemical corrosion in metal systems. As a result, a wide variety of steels and other alloys may be utilized as construction materials. Because of these characteristics of sodium, the engineering development of the sodium graphite reactor and its heat extraction system may eventually permit (1) the production of steam temperatures which will be limited only by turbine performance and (2) the simplification of the reactor cooling system to an extent approaching low-pressure water systems.

Sodium, however, is not without certain disadvantages. It reacts chemically with oxygen and water and must, therefore, be isolated from these substances. Further, when exposed to neutrons as in a reactor, it becomes a strong radioactive gamma ray emitter with a half-life of about 15 hours, thus creating a serious problem in nuclear power plant applications. For these reasons (in the present conceptions), the steam boiler has been separated from the primary sodium by a nonradioactive secondary sodium system which carries the heat from the primary system to the boiler. The vault necessary to contain the radioactive primary sodium provides the shielding required, and also acts as a container for the inert gas atmosphere surrounding the primary system.

Graphite was chosen as a moderator because it is mechanically easy to handle compared to liquid hydrogenous moderators, and is considerably less costly than beryllium, which might also be used. The principal disadvantage of graphite as a moderator is its porosity; it acts as a sponge when in contact with liquid sodium.

For a number of reasons, the permeation of the graphite by sodium must be prevented. The three most undesirable effects are: (1) the macroscopic cross-section increases from about 4×10^{-4} square centimeters for graphite alone to 3×10^{-3} square centimeters for graphite

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saturated with sodium; (2) the permeation of graphite is accompanied by a dimensional change of the order of +0.8 per cent, which would impose a significant design problem; (3) when sodium and graphite together are in contact with a third material, a slight corrosion of the graphite may occur, depending on the temperature and on the ability of the third material to take up carbon.

To separate the graphite physically from the sodium, the graphite elements are contained in sealed metal cans. Zirconium was selected as the can material because of its low neutron absorption cross-section and because it is relatively compatible with both sodium and graphite in the operating temperature range.

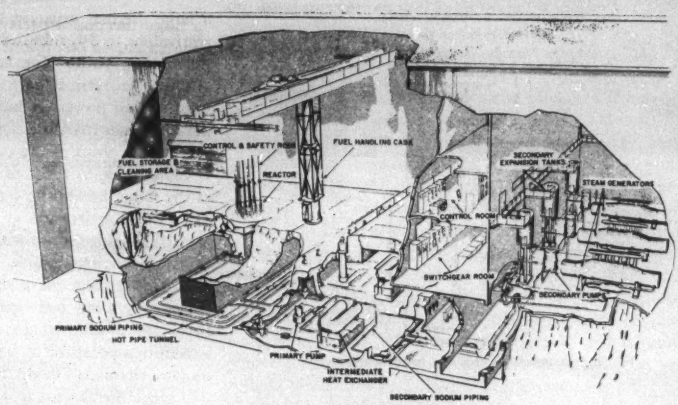

Fig. 1. SGR nuclear power plant layout.

DESCRIPTION

THE PROPOSED 75,000-kw central station power plant consists of the reactor core, the primary and secondary sodium cooling systems, the steam generators, and the electrical generating equipment. This plant was described in detail at the United Nations meeting in Geneva, Switzerland, in August 1955. Although the plant is essentially unchanged, there have been several recent reactor design modifications.

In the present layout, shown in Fig. 1, the reactor core, located below ground level, is contained in a large steel tank surrounded by concrete shielding. The sodium system design has been modified to solve certain practical difficulties and to make a more workable and efficient system. Three parallel primary loops connect the core to the intermediate heat exchangers. The primary piping runs through the hot-pipe tunnel to the three individual cells containing the components of each loop. The hot-pipe tunnel and the cells are individually shielded to permit shutdown and maintenance of one loop while the other loops continue to operate.

One complete sodium loop is shown schematically in Fig. 2. Primary sodium enters the core at 500 F and leaves at 925 F. A 50-F temperature difference exists across the intermediate heat exchanger so that secondary sodium enters the steam generator at 895 F. The total steam produced from the three heat transfer loops is 730,000 pounds per hour at 59 atmospheres and 883 F.

A simplified elevation of the reactor core is shown in Fig. 3. Sodium enters the core cavity at an elevation slightly above the top of the fuel elements and passes through downcomers outside of the core tank. It enters the tank below the fuel elements and flows upward through and around the fuel elements, leaving the core cavity at about the same level at which it entered. The output pipe has an upward, offset bend just outside of the core tank so that the high point in the system is external to the core tank. This means that in case of a leak in the piping in the hot tunnel, the sodium level in the core tank will not fall below the outlet nozzles, and, therefore, sodium flow can continue in the remaining loops.

The core contains 192 fuel elements spaced 9.5 inches apart in a triangular lattice. The active core is a cylinder, approximately 12 feet in diameter by 10-feet high, surrounded by a 2-foot graphite reflector.

An individual fuel element consists of a cluster of 19 rods. Each rod is made up of 10 slightly enriched uranium fuel slugs contained in a sealed stainless-steel jacket. The rods are spaced from each other by helically wrapped steel wires.

The moderator elements are graphite columns contained in sealed zirconium cans. The reflector elements are similar except that they do not contain fuel channels or coolant tubes.

The reactor operates at a specific power of 473 kilowatts per kilogram of U-235 with an inventory of 518 kilograms of U-235. The total weight of uranium in the reactor is approximately 22,500 kilograms. The average neutron flux is estimated at 2.0×10^{13} neutrons per cm^2-second with a peak-to-average ratio of 2.15. The initial enrichment of the fuel is 2.3 per cent U-235, which provides sufficient excess reactivity to overcome equilibrium xenon poisoning (3.0 per cent), temperature effects (0.5 per cent), fuel depletion (2.0 per cent), and xenon transient resulting from power cutback (1.0 per cent). The conversion ratio is approximately 0.72.

Two reactor core designs have been developed for this plant—the one just described for use with uranium fuel, and a second for use with thorium-base fuel. The two cores differ only in type of fuel element utilized and in

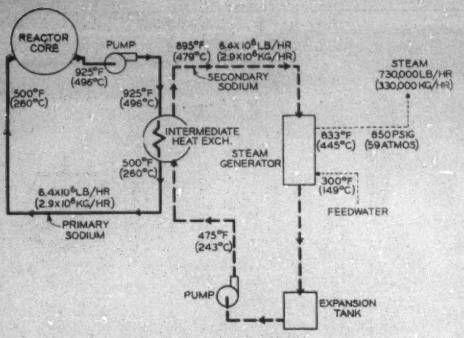

Fig. 2. Schematic flow diagram, heat transfer system.

certain physical dimensions; they are identical in all other respects.

Present research and development on the uranium-fueled SGR are aimed at improving the core design. For instance, different moderator configurations are being studied in an attempt to simplify the fabrication of the moderator elements. It would also be desirable to use stainless steel in place of zirconium as the moderator can material. The results of the studies now in progress will possibly improve reactor performance and also simplify fabrication and construction methods.

SAFETY CONSIDERATIONS

AMONG THE MAJOR ADVANTAGES of the SGR is its inherent safety. One of the more important safety features has already been mentioned; this is the nonpressurized heat-transfer system, which is possible in this reactor because of the high boiling point of sodium. Another inherent safety feature is the negative temperature coefficient of reactivity. There are actually two temperature coefficients of reactivity: a transient coefficient for the uranium fuel and a steady coefficient for the moderator. The transient coefficient has a value of -2.5×10^{-5} per degree C and is immediately effective in checking a sudden power rise. The steady coefficient has a value of -3×10^{-5} per degree C and comes into effect more slowly when the power increases. These coefficients are cumulative, so that the total coefficient of reactivity is -5.5×10^{-5} per degree C. In normal operation, the negative coefficient stabilizes the reactor power level. In the case of multiple simultaneous failures resulting in a change in reactivity, it comes into play to check the power rise.

Like other heat machines, reactors have thermal capacities which are relatively small by comparison with the rated power output. Among reactors, the sodium graphite system has perhaps the largest thermal capacity for a given power rating. The heat capacity of the fuel alone is such that it can absorb energy equivalent to 1½ minutes at full power before reaching the molten state. The sodium coolant in the primary system also has a large thermal capacity; the sodium can absorb energy equivalent to 3½ minutes at full power before reaching the boiling point. The heat capacity of the moderator graphite is even larger; the graphite will absorb 5½ minutes full power output of the reactor before its temperature rises from the normal operation temperature to the boiling point of the coolant. The SGR heat capacity is comparable to those of conventional fuel-fired boilers of the same thermal power ratings.

To avoid generation of temperatures which will cause a weakening or failure within the plant, the heat-generation rate obviously must not be allowed to exceed the heat-removal rate for a significant length of time. The balance between heat generation and removal is continuously monitored in the SGR, by measuring the sodium temperature in the reactor at the outlets of the coolant channels. Temperatures above the design point will cause the reactor to be shut down automatically, or "scrammed." A reactor neutron flux corresponding to 125 per cent of the designed power will also cause the reactor to scram, since this represents approximately the maximum capacity of the heat removal system. A third event which will produce a scram is loss of electric power to the coolant pumps, inasmuch as this represents a loss in the ability to remove full-power heat. A fourth automatic scram circuit is responsive to a rapid change in neutron flux in the reactor, since this foretells a rise in the reactor power output which may exceed the capacity of the cooling system. This is the so-called flux period trip.

A characteristic peculiar to nuclear reactors is that the rate of change of power, rather than power itself, is proportional to the displacement of the control elements. Once the control rods are displaced from the critical position, the power will continue to rise. Reactors are protected against excessive rod withdrawal and an accompanying rapid rate of power rise by the neutron flux period scram described earlier.

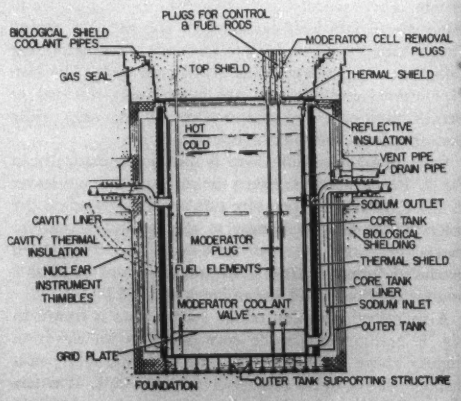

Fig. 3. Reactor core.

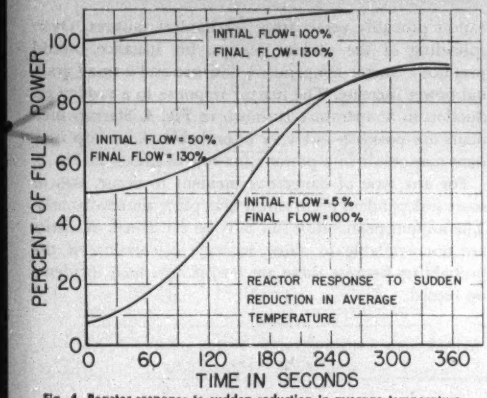

Fig. 4. Reactor response to sudden reduction in average temperature.

A second characteristic peculiar to nuclear reactors is the presence of afterglow heat in the fuel. Although the reactor is shut down, that is, the neutron flux is substantially zero, heat continues to be generated at an ever-decreasing rate as a result of the decay of the radioactive fission products. The SGR is protected from afterglow heat by the over-all reactor and cooling system design, which prevents interruption of coolant flow over the fuel elements under any conditions.

Sodium graphite reactors are inherently safe against the release of chemical energy as a result of the compatibility of the materials of construction. There is no reaction between uranium, sodium, NaK, steel, and graphite, which make up the core, or between these materials and the inert blanketing gases, helium and nitrogen, and the organic-shield coolant. While sodium will react with oxygen in the air, air is excluded from the reactor and from the cooling system vaults by the biological shield. A helium or argon atmosphere is maintained over the sodium pool in the reactor, whereas the components of the primary system are surrounded by an inert atmosphere of nitrogen.

There is, of course, the possibility of chemical reaction between the sodium and air, and between the shield coolant and air outside of the reactor. It is also energetically possible to have a reaction between the sodium and water in the steam-generator portion of the steam plant. The sodium-air and sodium-water reactions will not be considered, since under no circumstances would the sodium be radioactive. The hazards may be evaluated as they would be for a chemical plant handling the same materials. For similar reasons, the fire hazards for the organic-shield coolant will not be discussed. Experiments have shown that impurities in commercial grades of these materials are small and the radioactivity induced when used as a shield coolant in the reactor will be negligible. It should be pointed out, however, that these materials will be handled as inflammable fluids and that the usual precautions will be followed; that is to say, pipe trenches will be ventilated and explosionproof wiring will be used in areas close to the floor and in pits in the reactor building.

Only fission constitutes a potential source of energy in the SGR which might damage the reactor. It should be pointed out immediately that this fission energy may never manifest itself with explosive violence. The reasons for this are (1) the long neutron generation time, (2) the limit on the maximum excess reactivity which can be loaded into the reactor, (3) the limit placed on the time rate of release of reactivity, and (4) the presence of a negative temperature coefficient of reactivity. The long neutron generation time is the result of the graphite moderator in the reactor. This makes the reactor a thermal system in which the neutron generation time is thousands of times that for an atomic bomb. The excess reactivity which can be loaded into the reactor is fixed by the enrichment of the fuel delivered to the plant and by the number of fuel channels in the reactor. In normal operation, the rates of change or reactivity are limited to small values by the design of the control rod actuating mechanism. Under accident conditions, as for example in the dropping of a fuel element, the total change in reactivity is fixed by the gravity fall of the element. It should be noted that the negative temperature coefficient which is related to the fuel is a "prompt" coefficient and becomes effective immediately as the reactor fuel temperature increases. The energy released, furthermore, in any incident having a reasonable probability of occurrence is small in terms of energy release per unit weight of the fuel. Hence, it does not result in any explosive vaporization of the fuel, but appears rather as a relatively slow melting of the metal fuel slugs.

The SGR has a number of safety circuits and no harmful accident can result as long as the safety circuits are functioning properly. Nuclear incidents which result in damage can happen only when at least two events occur simultaneously, one of which is always the failure of a safety circuit (or several safety circuits, since each safety circuit is paralleled).

It should be noted that the heat capacities of the principal core components are substantially greater than the

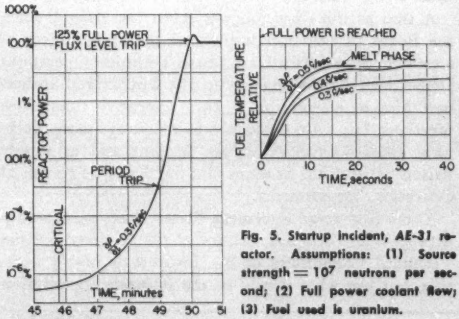

Fig. 5. Startup incident, AE-31 reactor. Assumptions: (1) Source strength = 10^7 neutrons per second; (2) Full power coolant flow; (3) Fuel used is uranium.

energy which would be released by even an extreme nuclear incident. A large nuclear incident would require the sudden addition of 2 per-cent reactivity. There is no way that this amount of reactivity could be added suddenly. This would release about 11 units of energy (1 unit equals 10^8 calories in this particular situation) of which about 0.5 unit would go into melting fuel and 10.5 units into raising the temperature of the remaining fuel, but not melting it. This energy would then be transferred to the sodium which would increase its temperature about 80 F, to about 1,030 F.

Several nuclear incidents which conceivably could occur in the SGR have been studied. The more likely ones would probably result from mechanical failures. Overspreading of the coolant pumps, for instance, would produce a reactor temperature decrease and a small gradual power increase. The reactor response to a sudden reduction in temperature is shown in Fig. 4. Startup incidents are possible, but very improbable. A startup incident may result in a power runaway, as shown in Fig. 5.

For any type of dangerous incident to occur, two or more independent events must take place simultaneously. The annual probability can only be estimated. Statistics are not available to allow accurate calculation of the probability because there are few, if any, such incidents on record.

The AIEE Technical Divisions

W. R. CLARK
MEMBER AIEE

The Chairman of the AIEE Technical Operations Department presents a proposal for changing the organizational structure of the Institute to provide a closer relationship between the Technical Groups of the Sections and the Technical Committees.

TECHNICAL GROUPS, or Discussion Groups as they have sometimes been called, have been in existence in AIEE Sections since about 1940. They have proved highly successful and very popular with the more technical minded members of our Sections. They have been very popular with the young engineers. Some Sections have been more active than others in promoting Technical Groups, but until last August there has been no major attempt to co-ordinate the Technical Group activities of one section with those of another or with those of the Technical Committees of the Institute.

A step in this direction was taken last August when the Board of Directors authorized the appointment of a member of each District to be the Technical Operations Department Representative in that District and authorized him to attend the District Executive Committee Meetings. His main duties are to encourage more Technical Group activities in the Sections and to supply liaison between the Sections and the T.O.D. (Technical Operations Department).

There is general agreement that a closer relationship between the Technical Groups of the Sections and the Technical Committees of the Institute is highly desirable, but just what should be the ultimate organization is a question that remains to be solved. This article proposes a solution to this problem. It is a typical engineering solution; it has its advantages and its disadvantages; its pros and cons. One big advantage of this proposal is that it uses the existing AIEE organization structure and, with but little modification, results in what should prove to be a very workable arrangement.

THE PROPOSAL

IT DOES NOT APPEAR DESIRABLE to have an organization in AIEE in which each Technical Committee of the Institute would have as its counterpart a corresponding Technical Group in the Section, each such group being

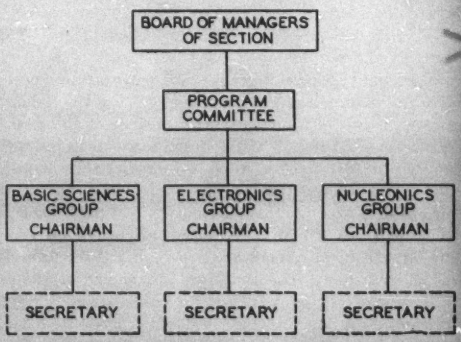

Fig. 1. Typical organization chart for a Section having one or more Technical Groups.

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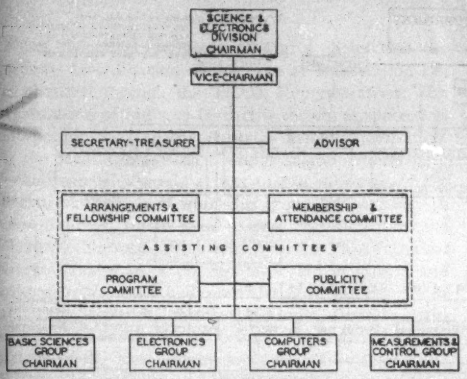

Fig. 2. Science and Electronics Division, Philadelphia Section.

its own independent organization with its own membership and its own publication. Other societies have used this scheme, but with a total of 48 technical committees, a scheme of this type would not be suitable to the AIEE. It would be unwieldy and confusing.

If, however, the same philosophy is applied in organizing the Technical Groups of a Section as was used in organizing the Committees of the Institute, a logical organizational structure is indicated. Technical Groups in most Sections each have a chairman and possibly a secretary. The chairman usually reports to the Program Committee of the Section, which in turn reports to the Board of Managers of the Section. This organization is shown in Fig. 1.

One Section, the Philadelphia Section, last year organized its Technical Groups into Divisions to obtain a better co-ordinated operating unit of Groups having somewhat similar interests (*Electrical Engineering*, August 1955, pp. 831-3). The organization chart of one of their Divisions is shown in Fig. 2. The Division Chairman is a member of the Board of Managers and has full voting rights.

Four additional committees have been added to assist in operating the Division. This alignment of the groups, excluding the assisting committees, is quite similar to the Institute Technical Division organization as shown in Fig. 3. Only one complete Division is shown because space does not permit showing the complete organization.

If the Technical Groups in all Sections were arranged in a similar fashion to that shown in Fig. 2, it would be relatively easy to establish AIEE Technical Divisions in which the activities of the Technical Divisions of the Sections would cover the same technical areas as the Technical Divisions of the Institute. With this type of organization, a well co-ordinated unit can be easily established and the necessary line of communications between the Technical Operations Department and the Technical Groups of the Sections can be readily provided. The chart for this type of an organization is shown in Fig. 4.

At present, as can be seen from Fig. 4, there are six Institute Division Committees. Just whether or not this is the right alignment of Divisions is a matter for future

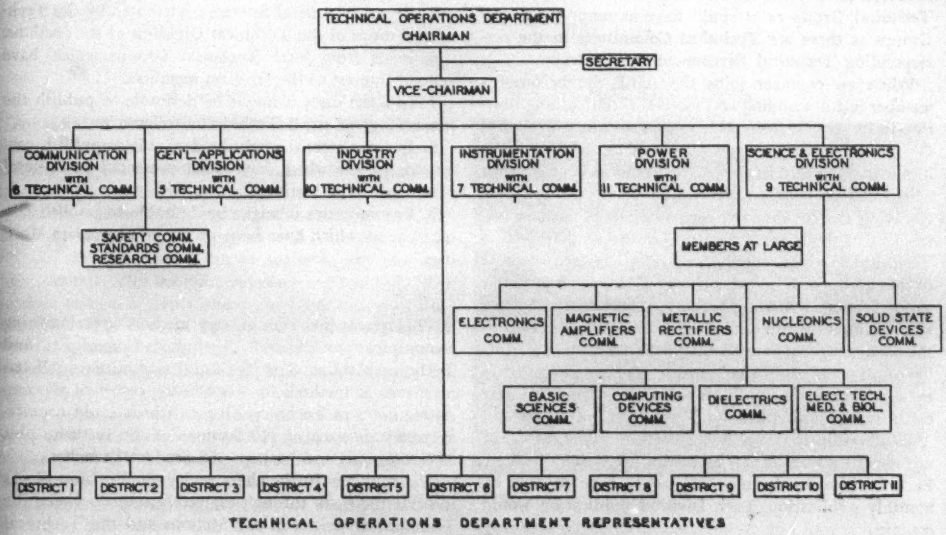

Fig. 3. The Technical Operations Department.

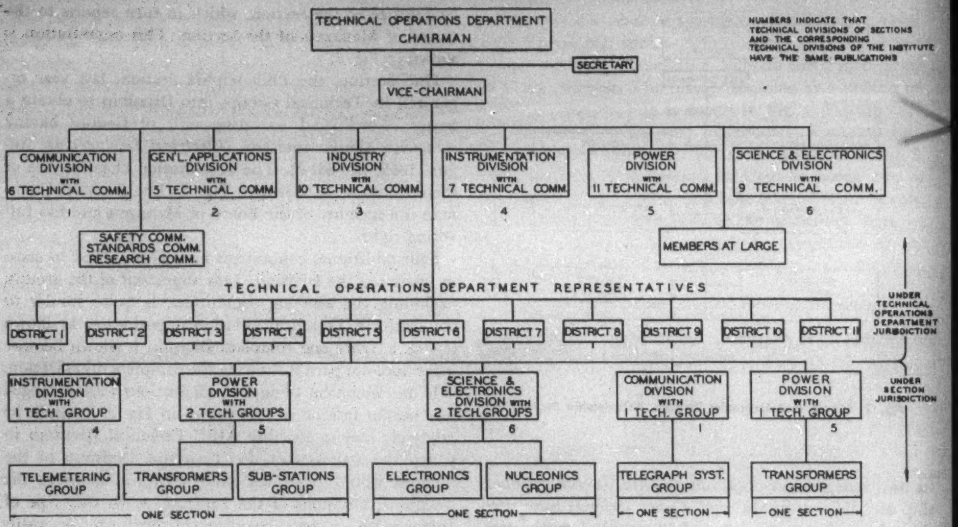

Fig. 4. Chart for proposed Technical Division organization.

consideration, but this Division setup could be used in the original organization.

Each Division in each Section would have the same name as the Division Committee of the Institute. The Technical Groups of each Division of the Section should have the same name as the Technical Committees of the Institute. A Division in a Section could have only one Technical Group or it could have as many Technical Groups as there are Technical Committees in the corresponding Technical Division of the Institute.

When an engineer joins the AIEE, he becomes a member in full standing and receives *Electrical Engineering*, in its present form. If he wants to join a Technical Group in a Section he pays a nominal fee which entitles him to membership in the AIEE Technical Division with which that particular Technical Group is associated. He also, if he desires, can have his name placed on the mailing lists of the other Technical Groups of that Section Technical Division and become a full fledged member of that group with no extra charge. This makes available to the Sections a mailing list of members of that Section who are interested in each Technical Group operated by the Section. It makes available to the Institute a mailing list of all members of the Institute who are interested in each Technical Group. This would be most helpful in establishing mailing lists for Technical Conferences.

Membership in a Technical Division also entitles the member to a publication associated with that Division. Each Division in the proposal would have its own bimonthly publication. Each Division publication would contain

1. The transaction papers of that Division.
2. Items from Minutes of T.O.D. Meetings of interest to Division members.
3. Items from the Minutes of Institute Division Committee Meetings of interest to Division members.
4. Items from the Minutes of Institute Technical Committee Meetings of that Division of interest to the Division members.
5. Papers of general interest contributed by the Technical Groups of the Technical Divisions of the Sections.
6. Items from local Technical Groups which have general interest to the Division members.
7. In some cases it might be desirable to publish the proceedings of small Technical Conferences.
8. In some cases it might be desirable to publish conference papers which have been presented at General Meetings of the Institute.
9. In some cases it might be desirable to publish District papers which have been presented at District Meetings.

This system furnishes an easy method of maintaining communications between Technical Committees and Technical Groups. The Technical Committee itself has no means or methods for distributing copies of all committee notes to Technical Groups which could conceivably exist in each of 110 Sections of the Institute plus 65 Subsections and perhaps 152 Student Branches.

The numbers in the chart under the Division blocks indicate the tie-in through the publications between the Technical Divisions of the Sections and the Technical Divisions of the Institute.

CO-ORDINATION

THE ORGANIZATION CHART of Fig. 4 shows that the necessary co-ordination of this type of organization can be obtained through the T.O.D. Representatives. The organization of just one District is shown, as space does not permit showing the entire proposed organization. At the Section level each Technical Group would have a chairman who would report to the chairman of the Technical Division of which his group is a member. In some Sections, where there is only one Group in the Division, this may be the same person. The Technical Division chairman of the Section would be guided and assisted by the T.O.D. Representative of the District of which the Section is a member. Technical Division chairmen for the Section would be of course under the jurisdiction of the local Section and selected by them. The T.O.D. Representative, who is appointed by mutual agreement between the District Vice-President and the Chairman of the T.O.D., reports to the T.O.D. and sits in on all their meetings. This provides the desired liaison.

The Technical Division chairmen of the Sections of a District would meet at the same time and place as the District Executive Committee. It would be sufficient to have just one Technical Division chairman from each Section of the District attend this meeting, but it would not necessarily have to be limited to just one Division chairman from each Section.

The chart has been drawn to show the similarity of the organization to that in existence at present. In operation, there would be a close tie-in, especially through the publications, between the Technical Division of the Institute and the Technical Division of the Section. This tie-in is indicated in the chart by corresponding numbers under the Division blocks. To establish a rigid straight-line organization between Divisions of the Institute and Divisions of the Sections for administrative purposes would result in more expensive operation than the proposed system. In reality what has been proposed is a Technical Operations Department for each District which would work in close co-operation at the top level (T.O.D. Representatives) with the Technical Operations Department of the Institute.

This completes a brief description of the proposed organization. There are various details remaining which need to be explored, but it is at least a start. It provides a definite tie-in between the Technical Group of the Section and the corresponding Technical Committee of the Institute by a method which will not be too expensive to maintain. It provides a direct means of communication by a reasonable number of publications (6 at present) without requiring a separate publication for each Technical Group–Technical Committee combination (48).

CONCLUSION

THE REASON for publishing this proposal in *Electrical Engineering* is that the desirability of a closer relationship between Technical Groups of the Sections and Technical Committees of the Institute is going to be the subject of the T.O.D. Forum scheduled for Wednesday evening, January 23, 1957 at the Winter General Meeting. It is presented so that those interested in Technical Committee activities of the Institute and those interested in Technical Group activities of the Sections can come to the Forum prepared to discuss the problem and the proposed organization.

Flashlight Operates by Means of Radioisotopes

An atomic flashlight, which will provide light for many years without the aid of batteries or external power sources, has been developed by scientists of the New England Nuclear Corp., Boston, Mass.

Utilizing an essentially nonhazardous radioisotope, the flashlight has been manufactured with a variety of light outputs and colors, and can be made in any size and shape desired. With the light from only one flashlight, it is possible to read a map without any other source of illumination. The eyes, of course, should be allowed to become at least partially dark-adapted first. The picture at the right was taken in absolute darkness, with only the light given off by the flashlights.

The continuous light-emitting devices are unaffected by climate, moisture, temperature, and other external factors. They could be used to illuminate dials and critical controls in submarines and aircraft, in underwater diving gear as markers and lights, for location markers at exits in theaters and halls, and as emergency lights in blackouts. Unlike radium, long used for dials, the new lights give off no harmful radiation and have a life that is years longer.

INSTITUTE ACTIVITIES

To All Members of the Institute:

My cordial Greetings to each of you and may each of your homes be filled with Joy and Happiness throughout the New Year.

M S Coover

President, AIEE

Winter General Meeting To Feature One of AIEE's Largest Technical Programs

THE AIEE Winter General Meeting, to be held at the Hotel Statler (meeting headquarters) and the Hotel Sheraton-McAlpin, New York, N. Y., January 21-25, 1957, will feature one of the largest technical programs in the history of the Institute. The social activities, for which the Winter General Meeting is well known, will again be outstanding. A group of varied and interesting inspection trips has been arranged closely allied with the technical sessions.

The January 24, 2 p.m. session will be a joint meeting of AIEE in New York, N. Y., Institution of Electrical Engineers in London, England, and the Engineering Institute of Canada in Montreal, Que., using the new transatlantic submarine telephone cable system to tie the three sessions together. Discussions of the unique features of the new system will take place over the cable, and the audiences in all three cities will be able to hear the discussions.

Prominent engineers and scientists in the three cities will take part. The presidents of the societies will preside at their respective meetings.

General Session

The featured speaker at the General Session on Monday afternoon, January 21, will be F. R. Kappel, president of the American Telephone and Telegraph Company. During this session, the Edison Medal will be awarded to Dr. C. A. Adams, past president of the Institute. (See page 82 of this issue of *Electrical Engineering*.) The AIEE Prize Paper Awards will also be presented at this time. President M. S. Coover will open the session with his report to the members of the Institute.

Hotel Reservations

Names of hotels in which blocks of rooms have been set aside for AIEE, including a list of rates for various rooms, can be found in the December issue of *Electrical Engineering*, page 1107.

Social Events

Details of the social events—informal tea, smoker, dinner-dance, ladies entertainment, and shows—also appeared in the December issue of *Electrical Engineering*, pages 1107-8. There are two additions to the list of shows playing in New York for which tickets are available. They are "Li'l Abner" (evenings—$9.15, Wednesday matinee—$5.90) and "Major Barbara" (evenings—$8.00, Wednesday matinee—$5.70).

Inspection Trips

A program of inspection trips of both technical and general interest has been arranged for those attending the Winter General Meeting. Because the number of persons who may be accommodated on each of these trips is limited, members who are interested are urged to make arrangements and obtain full details at the Inspection Trips desk immediately after registering. Advance registration by mail will be accepted from "out-of-towners" only for the trips to Brookhaven National Laboratory, Bell Telephone Laboratories, and the Merchant Marine Academy.

On some of the trips, proof of U.S. Citizenship will be required, and members should be prepared to comply with such security regulations which may be in force at the time of the trip.

A listing of the inspection trips to be included in the Winter General Meeting program follows.

Radio City Music Hall, New York, N. Y. (Tuesday morning, January 22, 1957)

International Business Machines Corporation, New York, N. Y. (Tuesday morning, January 22; Wednesday afternon, January 23; Thursday afternoon, January 24)

Grumman Aircraft Engineering Corporation, Bethpage, L. I., N. Y. (Tuesday morning, January 22)

Ford Motor Company, Mahwah, N. J. (Tuesday afternoon, January 22)

U. S. Merchant Marine Academy, Kings Point, N. Y. (Wednesday morning, January 23)

Fairless Steel Plant, Fairless, Pa. (All day Wednesday, January 23)

Bell Telephone Laboratories, Murray Hill, N. J. (Tuesday afternoon, January 22)

Steinway and Sons, Astoria, L. I., N. Y. (Wednesday morning, January 23)

East River Generating Station, Consolidated Edison Company of New York, Inc., New York, N. Y. (Wednesday morning and afternoon, January 23)

Lincoln Tunnel, Third Tube (Wednesday afternon, January 23)

Brookhaven National Laboratory, Upton, N. Y. (All day Thursday, January 24)

Bulova Watch Company, Jackson Heights, N. Y. (Thursday morning, January 24)

Western Electric Company, Kearny, N. J. (All day Thursday, January 24)

Electrical Testing Laboratories, Inc., New York, N. Y. (Thursday afternoon, January 24)

New York Coliseum, New York, N. Y. (Thursday afternoon, January 24)

AIEE Winter General Meeting, New York, N. Y., January 21-25, 1957

Tentative Technical Program

Monday, January 21

10:00 a.m. Substations

CP57-49. Energized Insulator Washing in Substations. *J. M. Mabe*, Central Power and Light Company

CP57-69. Substation Design Standards and Shortcuts Save Manpower. *R. F. Stevens*, U. S. Department of the Interior

57-53. Supervisory Control of Transmission Terminals at Generating Stations. *M. C. Hodges*, Commonwealth Edison Company

57-70. Operational Record of Supervisory Equipments on the Southern California Edison Company System. *J. D. Cleary*, Southern California Edison Company

10:00 a.m. Insulated Conductors

CP.* Compression Forces Influencing Pipe Type Cables. *E. I. Merrell, A. L. McKeen*

57-66. Soil Factors Affecting Buried Pipe Cable Temperatures. *C. A. Bauer, R. J. Neuse*, Commonwealth Edison Company

CP57-67. Aluminum Alloy Armour Wire for Submarine Cables. *E. D. Bent, W. J. Purdy*, Northern Electric Company, Ltd.

CP57-68. The Effect of the Frequency of Bending Cycles on the Fatigue Life of Cable Sheathing. *C. E. Betser*, Commonwealth Edison Company

CP.* A Pioneer 230-Kv Pipe Cable Installation. *W. A. DelMar, E. I. Merrell*

10:00 a.m. Relays

57-18. A New Line of Protective Relays and Cases. *J. L. Blackburn, W. E. Glassburn*, Westinghouse Electric Corporation

CP57-71. Interim Report on Revisions to Relay Standards. Relay Standards Subcommittee of the AIEE Committee on Relays

57-72. Bibliography of Relay Literature. Subcommittee on Bibliography of Relay Literature of the AIEE Relays Committee

57-31. Detection of Faults in Power Transformers. *E. A. Klingshirn*, Youngstown University; *H. R. Moore, E. C. Wentz*, Westinghouse Electric Corporation

10:00 a.m. Analog Techniques

CP57-193. A Differentiator for A-C Computers. *W. X. Johnson*, Radio Corporation of America (RCA)

CP.* A New Method for Generating a Function of Two Independent Variables. *L. C. Polimeros*, Convair

CP.* Bi-Variable Function Generation. *J. Lovell*, General Electric Company

CP.* The Operational Amplifier as a Laboratory Tool. *P. E. Pfeifer*, Rice Institute

CP.* Co-ordinated Use of Digital and Analog Computers. *E. M. Piper, K. B. Tuttle*, Northrop Aircraft Company

10:00 a.m. Nucleonics

10:00 a.m. Land Transportation

57-38. An 8,500-Horsepower Gas Turbine-Electric Locomotive. *R. M. Smith*, General Electric Company

CP57-39. Development and Use of the Gas Turbine Locomotive. *F. D. Cowans, A. H. Morey*, General Electric Company

57-16. The Case for a Standard System of Railroad Electrification for the American Railroads. *T. F. Perkinson*, General Electric Company

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* Conference papers will not be printed by the Institute; however, they may be available at the meeting at the discretion of the author.

PREPRINT PRICES

40¢ to Members
80¢ to Nonmembers

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NUMBERED PAPERS only are available.

SEND ORDER and remittance to:

AIEE Order Department
33 West 39th Street,
New York 18, N.Y.

10:00 a.m. Domestic and Commercial Applications

CP.* Four-Inch Diameter Motors for Submersible Water Well Systems. *M. J. Carroccio*, General Electric Company

CP57-26. Motor-Operated Switch for Space Heating Control. *J. C. Beckett*, Wesix Electric Heater Company

57-12. Load and Economic Aspects of the Residential Heat Pump on Electric Utility Systems. *C. W. Bary*, Philadelphia Electric Company

57-6. Single-Phase versus Three-Phase Service for Residential Air Conditioning. *A. S. Anderson, Chase Hutchinson*, Ebasco Services, Inc.

57-27. Some Problems and Design Factors Concerning Noise in Motor Driven Home Appliances. *E. R. Cunningham, G. L. Wolfert*, General Electric Company

10:00 a.m. Special Instruments and Auxiliary Apparatus

10:00 a.m. Communication Theory

CP.* Information Theory Impact on Modern Communication Theory. *P. Mertz*, Bell Telephone Laboratories, Inc.

CP.* Binary Codes for Combating Noise. *D. Slepian*, Bell Telephone Laboratories, Inc.

CP.* Speech Bandwidth Compression. *W. E. Kock*, Bendix Aviation Corporation

57-136. What Use Is Delta Modulation to the Transmission Engineer? *F. K. Bowers*, Bell Telephone Laboratories, Inc. Re-presented for discussion

56-963. Moment Detection and Coding. *I. J. Slade, Jr., S. Fich, L. F. Nanni, D. A. Molony*, Rutgers University. Re-presented for discussion

10:00 a.m. Industrial Power Systems

CP57-130. Experience in Operating 240- and 480-Volt Industrial Distribution Systems Ungrounded. *J. A. Glenger*, Eastman Kodak Company

57-1. Analysis of Irregular Current and Voltage Wave Shapes Found in Industrial Power Engineering. *R. H. Kaufmann*, General Electric Company

CP57-131. Electrical Surveys for Industrial Plants. *W. B. Rollins*, Anderson-Nichols and Company

CP.* Plant's Power Distribution System Has Face Lifting. *E. H. Howard*, General Electric Co.

10:00 a.m. Telegraph Systems

57-64. Multiplex Telegraph Equipment for Radio and Submarine Cable Circuits. *B. S. Diamond*, American Cable and Radio Corporation

57-65. A Predicted Wave Signalling Phase-Shift Telegraph System. *E. T. Heald, R. G. Clabaugh*, Collins Radio Company

CP.* A Flat-Bed Scanner of the Rotary-Mirror Type. *H. Strickholm, Edward Lincoln*, Times Facsimile Corporation

CP.* Facsimile Recording in Hydrographic Service. *Bernard Luskin*. Times Facsimile Corporation

CP.* Advancements in the Facsimile Art during 1956. *W. H. Bliss*, RCA Laboratories

2:00 p.m. General Session

Address: President M. S. Coover
Presentation of the Institute Prize Paper Awards
Presentation of the Edison Medal to Dr. C. A. Adams, past president of the Institute
Address: F. R. Kappel, president, American Telephone & Telegraph Company

Tuesday, January 22

9:30 a.m. Section Representatives

9:30 a.m. Transmission and Distribution

57-153. New Method for Computing Bearing Capacity of Block Foundations in Transmission Lines. *O. D. Zetterholm, B. O. Pramborg*, Swedish State Power Board

CP57-154. A 230-Kv Spar Arm H-Frame Transmission Line Design and Tests. *C. C. Dodge*, Stone and Webster Engineering Corporation

55-263. A Field Study of ACSR Cable in Severe Marine and Industrial Environment. *E. W. Greenfield, E. W. Everhart*, Kaiser Aluminum and Chemical Corporation. Re-presented for discussion

CP57-155. Appraisal—30 Year Old Wood Transmission Structures. *F. W. Smith*, Virginia Electric and Power Company

CP.* 69-Kv Dual Conductor Transmission Lines. *P. J. Croft*, Canada Wire and Cable Company; *Art Lee*, West Kootenay Power Company

CP.* The Corrosion of Malleable Iron. *O. R. Huggins*, Malleable Iron Fittings Company

9:30 a.m. Rotating Machinery

CP57-122. Divergence Analysis of D-C Machine Commutation. *S. J. Roumanis*, General Electric Company

CP57-133. An Analysis of D-C Machine Commutation. *J. R. M. Alger, D. T. Bowley*, General Electric Company

57-134. Carbon Brush Friction and Chatter. *E. I. Shobert II*, Stackpole Carbon Company

9:30 a.m. Transformers

57-115. Loading of Sealed Dry-Type Transformers. *L. C. Whitman*, General Electric Company

57-116. Protection of Series Capacitors Used with Distribution Transformers. *G. G. Auer, N. M. Neagle, L. W. Robbins*, General Electric Company

CP57-117. Transformer Noise Problem—Performance of Acoustic Treatments and Vibration Isolators. *A. T. Edwards*, The Hydro-Electric Power Commission of Ontario

CP.* Low Sound Transformers. *C. K. Kellenbach, M. W. Schulz, Jr., T. J. Twomey*, General Electric Company

9:30 a.m. Power System Communications

57-37. A New Approach to Power Line Carrier System Optimization. *W. H. Freeman*, Motorola, Inc.

57-35. Carrier Relaying Frequency Assignments Reduced to Numbers. *F. C. Krings*, General Electric Company

CP.* Evaluation of Operating Principles with Microwave Relaying. *J. Burdy, H. J. Fiedler, F. C. Krings, A. J. McConnell*, General Electric Company

9:30 a.m. Electrostatic Processes

CP57-87. Some Measurements of Abnormal Corona. *G. W. Penney*, Carnegie Institute of Technology; *J. G. Hewitt*, International Business Machines Corporation

CP57-46. Polarity and Temperature Effects in Corona for Charging Aerosols. *W. T. Sproull*, Western Precipitation Corporation

CP57-88. Power Supplies and Control for Electrostatic Precipitators. *J. W. Farr, J. T. Jamison, R. E. Trefzeisen*, General Electric Company

CP.* Automatic Control of Electrical Precipitation Rectifier Equipment. *H. E. Von Hoosen, H. J. Hall, H. J. White*, Research-Cottrell, Inc.

CP.* A Further Theoretical Analysis of the Charging of Fine Particles in a Corona Discharge. *A. T. Murphy, F. Adler, G. W. Penney*, Carnegie Institute of Technology

57-89. Measurements of Charge Imparted to Fine Particles by a Corona Discharge. *G. W. Penney*, Carnegie Institute of Technology; *R. D. Lynch*, Westinghouse Electric Corporation. Re-presented for discussion only

CP57-90. The Charging of Small Particles for Electrostatic Precipitation. *G. W. Hewitt*, Westinghouse Electric Corporation. Re-presented for discussion only

9:30 a.m. Symposium on Polyethylene Wire and Cable Insulation

CP.* New Developments and Trends in Polyethylene Wire and Cable Insulation. *A. E. Javitz, Electrical Manufacturing* Magazine

CP.* Thermal Embrittlement of the More Crystalline Polyethylene. *R. H. Carey, J. A. Synder, H. C. Vakos*, Bakelite Corporation

CP.* Polyethylene in Wire and Cable Use—Effects of Molecular Structures on Properties. *F. W. Spoka, H. J. Fray, Jr.*, E. I. du Pont de Nemours & Co. (Inc.)

CP.* Irrathene Irradiated Polyethylene—A New Insulating Material for Wire and Cable. *K. J. Mackenzie*, General Electric Company

CP57-86. Impulse Breakdown of Electrically Prestressed Polyethylene. *S. R. Vail*, Duke University

9:30 a.m. Land Transportation

57-216. Electrical Equipment of the New Haven Speed Merchant Locomotives. *T. T. Means, R. M. Henderson*

CP57-63. Electrical Aspects of High Speed Self-Propelled Train for the New Haven. *J. E. Burton*, The Budd Company

57-30. Diesel Locomotives with Mechydro Hydraulic Transmission for Lightweight Trains. *S. F. Steinbrock*, Baldwin-Lima-Hamilton Corporation

57-15. Design and Analysis of the Motor-Alternator Speed Regulator for the New Haven Speed Merchant Locomotive. *S. W. McElhanny*, General Electric Company

9:30 a.m. Applied Mathematics

57-104. The Development of a New Method of Circuit Analysis in Ladder Networks. *L. F. Cober*, Texas Technological College

57-107. A Describing Function Representation for the Multiple Nonlinearities of Electrohydraulic Control Valves. *John Zaborszky, H. J. Harrington*, McDonnell Aircraft Corporation

57-108. Generalized Charts of the Effects of Nonlinearities in Electrohydraulic Control Valves. *John Zaborszky, H. J. Harrington*, McDonnell Aircraft Corporation

57-109. Forces and Stresses in an Electromagnetic Field. *T. H. Lee*, General Electric Company

9:30 a.m. Chemical Processes Subcommittee.

CP.* The Use and Performance of Polyethylene Power Cable in Chemical Plants. *J. C. Norton, G. O. Wardrop*, Carbide and Carbon Chemicals Co.

CP.* New Electrical Construction Approach for Ammonium Nitrate Facilities. *R. G. Rudrow*, Atlas Powder Company

CP.* Use of Water Sprays for Outdoor Substation Structures. *W. W. Morkel*, Davison Chemical Company

9:30 a.m. Indicating and Integrating Instruments

57-111. An Inductronic Double Bridge. *J. H. Muller*, Weston Electrical Instrument Corporation. Re-presented for discussion

CP.* Phase Angle Measurements in the Audio Range. *David Alper*, Bendix Aviation Corporation

CP.* Principles and Practices for Standardizing Laboratories. *Dr. F. B. Silsbee*, U. S. Bureau of Standards

CP57-112. A Dynamic Torquemeter Utilizing the Reciprocal Wiedemann Effects. *M. J. O'Neill*, Perkin-Elmer Company

9:30 a.m. Digital Computer Techniques for Electrical Engineering Problems

CP.* Numerical Analysis of Physical Systems Using Digital Computers. *R. W. Ferguson, P. A. Zaphyr, E. L. Harder*, Westinghouse Electric Corporation

CP57-194. Some Practical Mathematical Techniques. *C. K. Carter*, General Electric Company

CP.* Application of Computers to the Analysis of Sudden Short-Circuit Oscillograms. *D. B. Harrington, J. I. Whittlesey*, General Electric Company

CP.* Numerical Techniques Used in the Application of Digital Computers to Power Systems Problems. *G. W. Stagg*, American Gas & Electric Company

2:00 p.m. Section Representatives

2:00 p.m. Transmission and Distribution

CP57-156. Conductor Economics on High-Voltage Transmission Systems. *J. M. Henderson, A. J. Wood*, General Electric Company

CP57-157. The Economics of Subtransmission Planning. *D. N. Reps*, Westinghouse Electric Corporation

CP57-158. 345-Kv Transmission—A Progress Report. *H. P. St. Clair*, American Gas and Electric Service Corporation

CP57-159. Representation of Induction Motor Loads during Power System Stability Studies. *D. S. Brereton, D. G. Lewis, C. C. Young*, General Electric Company

CP.* Performance Charts for Three-Phase Transmission Circuits under Balance Operation. *K. I. Cox, Edith Clarke*, University of Texas

57-160. Fault Location Methods for Overhead Lines. *R. F. Stevens, D. I. Marihart, T. W. Springfield*, Bonneville Power Administration

2:00 p.m. Rotating Machinery—Insulation

57-125. D-C Testing Experience on Rotating Machine Insulation. *J. S. Johnson, A. W. Zwisner*, Westinghouse Electric Corporation

57-126. Destructive Breakdown Test on a Large Turbine-Generator Stator Winding. *A. M. Nemetz*, Consumers Power Company; *M. S. Kirwen*, Commonwealth Associates, Inc.; *J. S. Johnson*, Westinghouse Electric Corporation

CP.* A High Voltage Surge Test for Detecting Faults between Turns of Rotating Machinery. *J. S. Johnson, R. E. Kelly*

CP.* Heat Flow in D-C Motor Field Coils as a Function of Insulation Deterioration. *C. P. Gibson, J. C. Schwarzkopf*

2:00 p.m. Transformers

57-48. Short Circuit Capability Tests of Load Tap Changer Mechanisms. *O. P. McCarty, W. M. Johnson*, General Electric Company

57-118. Electrode Area Effect for the Impulse Breakdown of Transformer Oil. *H. S. Endicott, K. H. Weber*, General Electric Company

CP.* Transformer Oil Preservation. *J. R. Meador, N. E. Dillow*, General Electric Company

CP57-119. Cascade Potential Transformers. *G. Camilli*, General Electric Company; *H. R. Lucas*, Canadian General Electric Company; *L. W. Marks, C. H. Tuttle*, General Electric Company

2:00 p.m. Relays and Power System Communications

2:00 p.m. Education in Electronics

Topic: Technicians Can Be Trained To Work as Junior Engineers

Theme: The need is well recognized, to utilize available manpower suitably, and to provide on-the-job education to improve the status of laboratory technicians, within their companies. The purpose of this panel discussion is to bring together viewpoints from industry, university, technical institute, and professional engineering; possibly to develop a standardized program and to increase the number of engineers available to the industry.

Participants:

Moderator—Dr. John Russell, General Electric Company

Industry—Thor Trolsen, General Electric Company

University—Dr. Eric Walker, Pennsylvania State University

Technical Institute—J. J. Gershon, DeVry Technical Institute

Professional Engineering—N. L. Freeman, New York State Board of Examiners of Professional Engineers and Land Surveyors

A Proposed Solution—C. F. Spitzer, General Electric Company

2:00 p.m. Symposium on Polyethylene Wire and Cable Insulation

CP.* Applications of Polyethylene in the Wire and Cable Industry. *E. J. Merrill*, Phelps Dodge Copper Products

CP.* The Polyethylenes for Higher Voltage Cables. *R. C. Graham*, Rome Cable Company

CP.* Use of Polyethylene Covered Conductor in the Niagara Mohawk System. *C. P. Adams, C. T. Nicholson*, Niagara Mohawk Power Company

CP.* Four Years of Experience with High Voltage Polyethylene Power Cables. *C. Martin, P. Flouck, B. Schmidt*, S. A. des Cableries et Trifileires, Switzerland. To be delivered by P. J. Croft, Canada Wire and Cable Corporation

CP.* Resilient Shielding—A New Construction in Polyethylene Power Cable. *E. D. Eich*, Anaconda Wire and Cable Company

2:00 p.m. Magnetics

CP.* Visit to Russian Conference on Magnetism. *R. M. Bozorth*, Bell Telephone Laboratories

CP.* Highlights of the 1956 AIEE Magnetic Conference. *C. P. Bean*

CP.* Fine-Particle Permanent Magnets—A Survey. *T. O. Paine, L. I. Mendelsohn, F. E. Luborsky*

CP.* Microwave Applications of Magnetic Materials. *John Pippin*

2:00 p.m. Land Transportation and Industrial Power Rectifiers

CP.* Rectifier Locomotives for the Virginian Railway. *J. C. Fox*, Virginian Railway Company

CP57-32. The Electric System of the Rectifier-Type Locomotives for the Virginian Railway. *J. C. Brown*, General Electric Company

CP57-33. Design of Ignitron Tubes for Rectifier Locomotives. *B. E. Belnap, J. L. Zehner, H. E. Zwers*, General Electric Company

CP.* Design Considerations for Rectifiers for Railway Locomotives. *C. C. Herskind, I. E. Hudson, W. R. Kettenring*, General Electric Company

CP.* Report on Progress and Trends in European Electrification. *E. H. Brown, C. B. Lewis, D. R. MacLeod*, General Electric Company

2:00 p.m. Safety

CP57-62. Lead-Acid Storage Batteries for Emergency Lighting and Power. *E. A. Hosie*, The Electric Storage Battery Company

CP.* A Branch-Circuit Wiring System Used at the Natural Bureau of Standards. *R. L. Lloyd*, National Bureau of Standards

CP.* Resuscitation from Electric Shock—Motion Pictures of Heart Fibrillation. *Dr. W. B. Kouwenhoven*, The Johns Hopkins University

57-35. Field Treatment of Electric Shock Cases I. *W. B. Kouwenhoven, W. R. Milnor*, The Johns Hopkins University

2:00 p.m. Indicating and Integrating Instruments

57-43. Compensation for Instrument Losses in Circuits Containing a Wattmeter, Voltmeter, and Ammeter. *N. M. Vrana*, Cornell University

CP.* A Stable Platform for Galvanometer Mounting. *Dr. F. K. Harris*

57-113. Mass Flowmeter with Retarding Disk Integration. *R. G. Ballard, J. R. Macintyre*, General Electric Company

57-114. The Clamp-Type Alternating-Current Microammeter. *G. F. Montgomery, Carroll Stansbury*, National Bureau of Standards

2:00 p.m. Radio Communications Systems

57-58. An Experimental Narrow Band FM Mobiltelephone System. *W. A. Miller*, The Pacific Telephone and Telegraph Company

CP.* RCA Multiplex/ARQ System. *A. Kahn, A. Liguori*

CP57-103. Modern Approach to Communication Systems Planning and Engineering. *V. J. Nesson*, Microwave Services, Inc.

57-59. Noise Considerations on Tell Telephone Microwave Radio Systems. *T. A. Combellick, M. E. Ferguson*, Lenkurt Electric Company

CP57-60. Design Factors for the Optimization of Multichannel Radio Systems. *C. A. Parry*, 11-20 Westview Ave., White Plains, N. Y.

CP57-61. Signal-to-Noise Ratios in Strong-Carrier FM Systems. *Harry Urkowitz*, Philco Corporation Research Division

56-1001. Some Results with Frequency Diversity in a Microwave Radio System. *F. H. Willis*, Bell Telephone Laboratories, Inc. Re-presented for discussion

Wednesday, January 23

9:30 a.m. Transmission and Distribution

CP57-161.† Colorado High Altitude Corona Tests Conductors, Towers, and Footings. *L. M. Robertson*, Public Service Company of Colorado; *H. M. Walton, O. H. Huggins, P. T. Coffin*, Aluminum Company of America; *R. C. York*, Hughes Bros., Inc.; *N. E. Dosenberg*, Ohio Edison Company

Colorado High Altitude Corona Tests—Insulators and Associated Hardware. *L. M. Robertson*, Public Service Company of Colorado; *A. D. Lantz, Jr.*, The Ohio Brass Company

Colorado High Altitude Corona Tests Scope, Tests, and Instrumentation. *L. M. Robertson*, Public Service Company of Colorado; *C. F. Wagner, T. J. Bliss*, Westinghouse Electric Corporation

CP.* Radio Noise Measurement on Denver-Shoshone Line of Public Service Company of Colorado. *L. M. Robertson, G. E. Adams, N. R. Schultz, H. A. Gauper, T. W. Liao*

9:30 a.m. Rotating Machinery—Synchronous

CP57-205. Stability Limits of a Synchronous Motor. *F. C. Tormollan*, University of Texas

57-127. Eddy Currents in the End Portion of Turbine-Generator Stator Windings. *G. W. Staats*, Allis-Chalmers Manufacturing Company

57-128. Harmonics of the Salient Pole Synchronous Machine and Their Effects Part II—Synchronous Torques. *M. M. Liwschitz-Garik*, Polytechnic Institute of Brooklyn

56-1010. Calculation of Windage Noise Power Level in Large Induction Motors. *M. E. Talaat*, Elliott Company. Re-presented for discussion

9:30 a.m. Transformers

CP.* Corona Measurements on Oil-Insulated Transformers. *E. J. Adolphson, F. J. Vogel*, Allis-Chalmers Manufacturing Company

57-40. Induced Losses in Steel Plates in the Presence of an Alternating Current. *W. C. Deuring*, General Electric Company

57-14. A Semiautomatic Test for Measuring the Loss in Transformer Core Laminations. *S. C. Leonard, R. L. VanBroeck*, General Electric Company

57-24. Stray Current Losses in Stranded Windings of Transformers. *H. J. Kaul*, Westinghouse Electric Corporation

9:30 a.m. Electronic Circuitry

57-31. Transistorized Phase Discriminators. *A. N. DeSautels*, Minneapolis-Honeywell Regulator Company

57-74. Upper Limits of Output Power in Vacuum Tube and Transistor A-C Amplifiers. *L. M. Vallese*, Polytechnic Institute of Brooklyn

57-75. An N-Stage Series Transistor Circuit. *K. H. Beck*, Minneapolis-Honeywell Regulator Company. Re-presented for discussion only

CP57-76. An Amplitude-Stabilized Bridged-T Oscillator. *Kurt Knolein*, University of Rochester

CP.* Noise Measurements by the Rothe Method. *Christoph Metzelmann*, General Electric Company

57-77. Simultaneous Pulled Oscillations in a Triode Oscillator Incorporating Two Oscillatory Circuits. *A. E. Mostafa*, Alexandria University, Alexandria, Egypt

9:30 a.m. Symposium on Gaseous Dielectrics

CP.* Considerations of the Toxicity of Gases. *Dr. D. Lester*, Yale University

CP57-82. The Use of Sulfur Hexafluoride in Wave Guides. *Tore Anderson, A. L. Reeves*, Airtron, Inc.; *W. H. Mears, S. R. Orfeo*, General Chemical Research Laboratories

CP57-83 Electrical Discharge Characteristics of the Plane Parallel Gap Bounded by Insulating Surfaces. *J. C. Devins*, General Electric Company

CP.* The Influence of Space-Charges on the Electric Breakdown of Sulfur Hexafluoride. *Daniel Berg, C. N. Works*, Westinghouse Research Laboratories

CP.* Corona Measurement and Interpretation. *T. W. Dakin*, Westinghouse Research Laboratories

9:30 a.m. Magnetic Amplifiers

57-5. On the Input Power of the Half-Wave Magnetic Amplifier Circuit. *T. Kikuchi*, Microwave Research Institute of Polytechnic Institute of Brooklyn; *K. Murakami*, Tohoku University, Japan

57-91. Magnetic Frequency Multipliers and Their Rating Part II—Frequency Sextuplers. *William McMurray*, General Electric Company

57-92. Self-Balancing Magnetic Amplifiers of the Differential Feedback Type. *W. A. Geyger*, U. S. Naval Ordnance Laboratory

57-93. Speed Control of a D-C Motor Using a Magnetic Amplifier. *W. Leonhard*, Westinghouse Electric Corporation

CP57-94. Dynamic Operation of Magnetic Amplifiers with Real Core and Rectifier Functions. *H. C. Bourne, Jr., D. Nitzan*, University of California

9:30 a.m. Research

9:30 a.m. Petroleum Industry

CP.* Purchased Electric Power for Modern Petroleum Refinery. *R. W. Mills, W. R. Ankrom*

CP.* Designing for Locations Having Group B Gases. *E. R. Hoyle, R. P. Northrup*

CP.* Modern Requirements for Oil Well Pumping. *J. K. Howell, S. S. Browne*, Westinghouse Electric Corporation

9:30 a.m. Wire Communications

57-137. General Aspects of Hands-Free Telephony. *J. W. Emling*, Bell Telephone Laboratories

CP.* Type 88 Loudspeaking Telephone. *E. S. Peterson*, Automatic Electric Company

57-138. The Hands-Free Telephone. *F. Rodek*, Stromberg-Carlson Company

57-139. The Bell System Speakerphone. *W. F. Clemency, F. F. Romanow*, Bell Telephone Laboratories; *A. F. Rose*, American Telephone and Telegraph Company

† All three papers listed under CP57-161 will be included in the price of one—80¢

Future AIEE Meetings

AIEE-IRE-RETMA-ASQC Symposium on Reliability and Quality Control*
Hotel Statler, Washington, D. C.
January 14-16, 1957

Winter General Meeting*
Hotel Statler, New York, N. Y.
January 21-25, 1957

AIEE-IRE-U of P Conference on Transistor and Solid State Circuits*
University of Pennsylvania,
Philadelphia, Pa.
February 14-15, 1957

AIEE-IRE-ACM Western Joint Computer Conference*
Hotel Statler, Los Angeles, Calif.
February 26-28, 1957

Textile Conference
Georgia Institute of Technology,
Atlanta, Ga.
March 7-8, 1957
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Jan. 2)

EJC Nuclear Engineering and Science Congress
Convention Hall, Philadelphia, Pa.
March 11-15, 1957
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Jan. 4)

AIEE-ASME Engineering Management Conference
Pittsburgh, Pa.
March 27-28, 1957
(Final date for †TP—closed, ‡CP Syn.—Jan. 11, CPMs—Jan. 22)

Paper and Pulp Conference
Georgia Institute of Technology,
Atlanta, Ga.
March 28-29, 1957
(Final date for †TP—closed, ‡CP Syn.—Jan. 11, CPMs—Jan. 22)

Southern District Meeting
Hotel Heidelberg, Jackson, Miss.
April 3-5, 1957
(Final date for †TP—Jan. 3, §DP Syn.—Jan. 18, DPMs—Jan. 30)

AIEE-AWS Electric Welding Conference
Municipal Auditorium,
Philadelphia, Pa.
April 8-12, 1957
(Final date for †TP—Jan. 8 ‡CP Syn.—Jan. 22, CPMs—Feb. 1)

Great Lakes District Meeting
Hotel Fort Des Moines,
Des Moines, Iowa
April 15-17, 1957
(Final date for †TP—Jan. 15, §DP Syn.—Jan. 30, DPMs—Feb. 8)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CP Syn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DP Syn. date is 10 days before the DPMs date)

Courtesy Brookhaven National Laboratory

AERIAL VIEW of excavation for 25 Billion Electron Volt Synchrotron Particle Accelerator expected to be in operation in 1960 at the Brookhaven National Laboratory, which will be visited during the Winter General Meeting. The Cosmotron building, housing the Three Billion Volt Accelerator is shown in the foreground.

9:30 a.m. Production and Application of Light

CP.* **Development and Application of High Frequency Fluorescent Lighting.** *J. H. Campbell, Q. D. Dobras,* General Electric Company

CP57-34. **840-Cycle Fluorescent Lighting.** *R. H. Burnham,* The Wakefield Company

CP57-893. **High Frequency Power and Distribution.** *V. C. Gechler,* General Motors Corporation

CP.* **High Frequency Fluorescent vs Standard Fluorescent Lighting Systems.** *W. H. Johnson, J. Winplinger,* Westinghouse Electric Corporation

9:30 a.m. Recording and Controlling Instruments

2:00 p.m. Transmission and Distribution

CP57-164. **Investigation of Radio Noise from Existing Lines and Equipment To Aid in the Design of Future Extra-High Voltage Lines.** *F. L. Taylor, C. J. Crockford, R. F. Nicolson,* The Detroit Edison Company

57-168. **The Calculation of Radio and Corona Characteristics of Transmission Line Conductors.** *C. J. Miller, Jr.,* The Ohio Brass Company

CP57-166. **Radio Interference from High-Voltage Transmission Lines as Influenced by the Line Design.** *C. E. Adams,* General Electric Company

57-167. **Relationship between Corona and Radio Noise on Transmission Lines, Laboratory Studies Part I—Point and Conductor Corona.** *T. W. Liao, W. A. Keen, Jr., D. R. Powell,* General Electric Company

CP.* **Relationship between Corona and Radio Noise on Transmission Lines, Laboratory Studies, Part II—Insulator, Hardware, and Conductor Corona.** *T. W. Liao,* General Electric Company

2:00 p.m. Rotating Machinery—Synchronous

CP57-139. **Effect of Clearing Time on Synchronous Machine Transient Stability.** *C. Shackshaft, A. S. Aldred,* The University of Liverpool

CP57-130. **A New Stator Coil Transposition for Large Machines.** *W. L. Ringland, L. T. Rosenberg,* Allis-Chalmers Manufacturing Company

CP57-131. **Gland Seal Systems for Modern Hydrogen-Cooled Turbine-Generators.** *R. A. Bandy, L. P. Curtis,* Westinghouse Electric Corporation

2:00 p.m. Electronic Circuitry

57-78. **Elimination of the Ballast Resistor in D-C Power Supplies.** *Stewart Krakauer,* The United States Time Corporation

57-79. **Economics of Multimillion Joule Inductive Energy Storage.** *H. C. Early,* University of Michigan; *R. C. Walker,* Bucknell University

CP57-80. **A Combined Mean and Sidereal Frequency Divider.** *H. F. Hastings,* Naval Research Laboratory

57-81. **Transient Analysis of Second Order Flip-Flops.** *L. M. Vallese,* Polytechnic Institute of Brooklyn

56-759. **Synchronization Accuracy Obtainable with Multiplier Phototubes.** *Leo Leal,* Fairchild Controls Corporation

56-757. **Magnetically Keyed, Phase-Sensitive Demodulators.** *R. B. Mark, P. R. Johannessen, W. T. Johnson,* Massachusetts Institute of Technology

2:00 p.m. Symposium on Radiation Effects

CP.* **The Effects of Radiation on Mylar.** *E. L. Brancato,* Naval Research Laboratories

CP.* **The Effect of Rate of Irradiation on the Breakdown Dosage for Kel-F.** *J. Goodman,* Radiation Research Corporation.

CP.* **The Effect of Temperature and Gamma Radiation on the Mechanical Properties of Some Wire Enamels and a Silicone.** *E. L. Mincher,* General Electric Company

CP.* **The Effects of Radiation on the Properties of Dielectric Materials.** *P. H. Klein,* General Electric Company

2:00 p.m. Magnetic Amplifiers

57-95. **Core-Reset Functions in Magnetic Amplifier Analysis Part I—A Core-Reset Function.** *C. C. Feth,* General Electric Company

CP57-96. **Steady-State Operation of the Push-Pull Saturable-Core Transformer with Resistive Load.** *R. E. Anderson,* General Electric Company

57-97. **Analysis of the Full-Wave Magnetic Amplifier Circuits Considering the Change of the Width of Dynamic Hysteresis Loop.** *Tadashi Kitsuki,* Polytechnic Institute of Brooklyn

CP57-3. **The Dynamically and Statically Controlled Magnetic Amplifier as a Multipurpose Relay.** *John Bande,* Allis-Chalmers Manufacturing Company

CP57-98. **Progress Report of the Standards Subcommittee of the AIEE Magnetic Amplifier Committee.**

2:00 p.m. Cathodic Protection

2:00 p.m. Wire Communications

57-10. **Development in Communications in the Lower St. Lawrence Valley.** *F. C. Doak, J. R. Tessier,* Quebec Telephone Company. Re-presented for discussion.

CP.* **A Transistorized Repeater for 48 EN Carrier.** *R. H. Fish, V. Bobis,* Lenkurt Electric Co.

CP.* **A Miniaturized Negative Impedance Voice Repeater Employing Transistors.** *A. S. Howell,* Stromberg-Carlson Company

57-140. **Buried Telephone Distribution Systems.** *C. L. Chilberg,* American Telephone and Telegraph Company

2:00 p.m. Education

2:00 p.m. Management

CP.* **Individual and Company Responsibilities for Development of the Engineer.** *H. B. Kipkuth*

CP.* **Effective Appraisal of Engineers.** *J. A. Newman,* Booz, Allen and Hamilton

2:00 p.m. Petroleum Industry

CP57-37. **Diesel-Electric Oil Well Drilling Equipment.** *O. J. Graham, Hillert Vitt,* General Electric Company

57-38. **Digital Telemetering and Print Out of Pipe Line Information.** *M. T. High,* Service Pipe Line Company

CP57-39. **Electronic Protective Devices for Pumping Units.** *Haskell Ginns,* Indikon Company; *W. W. Holt, Jr.,* Plantation Pipe Line Company

2:00 p.m. Satellite Telemetering

Thursday, January 24

9:30 a.m. Transmission and Distribution

57-168. **Distribution System Load Characteristics and Their Use in Planning and Design.** *R. B. Sarikas,* Illinois Power Company; *H. B. Thacher* Westinghouse Electric Corporation

CP57-169. **Economic Analysis of Residential Secondary Distribution Systems.** *H. E. Campbell, H. E. Sinnott,* General Electric Company

CP57-170. **High Speed Magnetic Air Breaker for Distribution Circuits.** *H. P. Sleeper,* Public Service Electric and Gas Company; *J. D. Findley,* Westinghouse Electric Corporation

CP.* **Switching Surges on Switching a Line and Transformer as a Unit.** *L. O. Barthold, I. B. Johnson, A. J. Schultz,* General Electric Company

57-171. **Switching Surges Due to De-energization of Capacitive Circuits.** Working Group on Switching Surges

9:30 a.m. Rotating Machinery—Induction

57-132. **Stopping Time and Energy Loss of A-C Motors with D-C Braking.** *O. I. Butler,* University of Sheffield

57-133. **Low Inertia Induction Motors.** *Maurice Apstein, Lester Blum,* Ordnance Corps, Diamond Ordnance Fuse Laboratories

57-134. **The Calculation of Can Losses in Canned Motors.** *R. C. Robinson, I. Rowe, L. E. Donelan,* Westinghouse Electric Corporation

57-135. **Induction Motor Speed-Torque-Current Curves with a Constant Rotor Temperature.** *R. F. Horrell, W. E. Wood,* Electric Machinery Manufacturing Company

CP57-8. **Circuit Constants of High Starting Torque Induction Motors from Tests.** *J. F. H. Douglas,* engineering consultant, Milwaukee, Wis.

9:30 a.m. Switchgear

57-174. **A New Compressed Air Dead Tank Circuit Breaker for Interrupting 10 Million Kva at 138 Kv.** *J. E. Schramack, R. E. Kane,* Westinghouse Electric Corporation

57-54. **A New 138-Kv, 10,000-Mva Air Blast Circuit Breaker.** *R. B. Shores, I. W. Beatty,* General Electric Company

57-175. **Design Features in a New Line of Outdoor Oil Circuit Breakers Rated 14.4 to 69 Kv.** *F. B. Johnson, G. B. Cushing,* Westinghouse Electric Corporation

CP57-176. **Low Voltage Testing for Oil Circuit Reclosers.** *T. M. Urban, E. J. Field,* I-T-E Circuit Breaker Company

9:30 a.m. Satellite Communications

9:30 a.m. Symposium on Liquid Dielectrics

CP57-84. **The Effect of Composition on the Oxidation Stability of Electrical Oils.** *J. L. Jeal, A. P. Stuart, E. S. Ross,* Sun Oil Company

CP.* **Effects of Arcs on Silicone Liquid Dielectrics.** *C. C. Currin, J. F. Dexter,* Dow Corning Corporation

CP.* **The D-C Conductivity of Simple Chlorinated Hydrocarbons.** *J. Hart, A. G. Mungall*, National Research Council of Canada

CP.* **The Causing of Liquid Dielectrics under Electric Stress—The Influence of Voltage and Pressure.** *H. Basseches, Mrs. M. W. Barnes*, Bell Telephone Laboratories

57-3. **Phenomena Accompanying Transient Low-Voltage Discharges in Liquid Dielectrics II. Cathode Phenomenas at Low Currents.** *E. M. Williams, R. E. Smith*, Carnegie Institute of Technology

9:30 a.m. Magnetic Amplifiers

57-99. **Circuit for a Magnetic Subharmonic Pulser.** *K. C. Hu*, Minneapolis-Honeywell Regulator Company; *Y. H. Ku*, University of Pennsylvania

57-306. **Proposed Size Standards for Toroidal Magnetic Tape-Wound Cores.**

CP57-100. **Magnetic Amplifier Analog Computation Techniques.** *H. W. Patton*, Airpax Products Company

CP57-101. **A New Static Magnetic Switching Circuit Using Combined "And" and "Or" Functions.** *R. E. Morgan*, General Electric Company

CP57-102. **Static Control with Magnetic Amplifier Logic Elements.** *J. Sheets*, General Electric Company

9:30 a.m. Research

9:30 a.m. System Engineering and Power Generation

57-142. **Effect of Speed Governor Dead Band on Tie-Line Power and Frequency Control Performances.** *C. Concordia, L. K. Kirchmayer*, General Electric Company; *E. A. Szymanski*, Wayne University

57-143. **Automatic Economic Dispatching and Load Control—Ohio Edison System.** *R. H. Travers*, Ohio Edison Company

CP57-144. **Economic Aspects of General Electric Automatic Dispatching System at Kansas City.** *D. H. Cameron, E. L. Mueller*, Kansas City Power and Light Company

57-145. **Forced Outage Rates of High Pressure Steam Turbines and Boilers.** Report by the AIEE Joint Subcommittee on Application of Probability Methods to Power System Problems of the AIEE Power Generation and System Engineering Committees

9:30 a.m. Semiconductors

CP.* **The First Decade of Transistors—1948-58.** *H. L. Owens*, Texas Instruments Corporation

CP.* **Germanium and Silicon Rectifiers—Present and Future.** *R. A. York*, General Electric Company

CP.* **Properties and Applications of Transistor Switches.** *E. N. Ross*, Bell Telephone Laboratories

CP.* **Present Status of Electroluminescence.** *Manuel Aven*, General Electric Company

9:30 a.m. Computing Devices and Education

CP.* **Requirements for Trained Personnel in the Data Processing Fields.** *S. N. Alexander*, National Bureau of Standards; *L. W. Cohen*, National Science Foundation

CP.* **The University of Michigan Curriculum Computer Applications.** *N. R. Scott*, University of Michigan

CP.* **A Curriculum in Computer Applications at the Moore School.** *S. Gorn, A. Matz, G. W. Patterson*, Moore School of Electrical Engineering

CP.* **The Role of Digital Computers in Engineering Education.** *A. J. Perlis*, Carnegie Institute of Technology

CP.* **The University of Illinois Curriculum in Digital Computers.** *A. H. Taub*, University of Illinois

56-937. **The Application of a Digital Computer in Design Engineering.** *J. C. White*, General Electric Company. Re-presented for discussion

9:30 a.m. Industrial Control

CP.* **Static Switching Systems for Industrial Applications.** *J. C. McMahon, B. P. Chausse*, General Electric Company

CP57-188. **Static Digital Control of a 6-Way Milling and Drilling Machine Tool.** *H. D. Stuart*, Westinghouse Electric Corporation; *T. J. Becker*, Michigan Drill Head Company

CP57-189. **Static Control in Automatic Warehousing.** *L. L. Bosch, A. J. Faulhorn*, Bosch and LeTour; *J. W. Stuart*, Westinghouse Electric Corporation.

CP57-190. **Cypak Computing Circuits.** *J. J. McNeill*, Westinghouse Electric Corporation

2:00 p.m. Transmission and Distribution, Protective Devices and Transformer

57-178. **A Quarter Century of Experience in Insulation Co-ordination: Basic Philosophy, Application, and Operating Experience on the American Gas and Electric Company System.** *Philip Sporn, I. W. Gross*, American Gas and Electric Service Corporations

57-35. **Operating Experience on AC&K 132-Kv System with Transformer Insulation Reduced Two Classes.** *P. S. Pugh, C. P. Zimmerman*, American Gas and Electric Service Corporation

CP.* **Transformers Designed for Operating Conditions.** *F. J. Vogel, G. W. Lengnick*, Allis-Chalmers Manufacturing Company

57-19. **Reduced Transformer Insulation.** *E. M. Hunter, I. R. Meador, W. J. Rudge*, General Electric Company

57-173. **Insulation Co-ordination as Affected by New Arrester Characteristics.** *A. M. Opsahl*, Westinghouse Electric Corporation

2:00 p.m. Switchgear

57-177. **Current Density and Temperature of High-Current Arcs.** *T. H. Lee, W. R. Wilson, J. C. Sofianek*, General Electric Company

CP57-178. **New Line of High Power Interrupters for Breakers Rated 69 Kv and Above.** *A. W. Hill, R. E. Friedrich*, Westinghouse Electric Corporation

CP.* **A New Approach to Automatic High Speed Grounding.** *C. W. Upton, F. C. Goldner*

CP57-50. **A New Concept of Control Panels for Automatic Switching of Power System Feeders.** *M. C. Harman*, S. & C. Electric Company

2:00 p.m. Optical—Electronic Tubes and Microwave Noise Source

CP.* **Miniaturization in Multiplier Phototubes.** *F. W. Schenkel*, Allen B. Du Mont Laboratories.

CP.* **Electrostatic Shutter Image Converter Tubes.** *B. R. Linden*, Allen B. Du Mont Laboratories, Inc.

CP.* **A Half-Tone Display Storage Tube with Magnetic Deflection.** *M. R. Craig*, Radio Corporation of America

CP.* **Multicolor Storage Tube.** *C. D. Barstema, S. T. Smith and L. L. Van Hull*, Hughes Research Laboratories

CP.* **New Noise Sources for Monitoring the Performance of Microwave Systems.** *R. H. Geiger*

2:00 p.m. Symposium on Thermal Aging

CP.* **Statistical Methods Applied to Thermal Evaluation of Insulating Materials.** Working Group Report

CP.* **Heat Aging of Class B Varnish Wire Enamel Systems—Heat Resistance of Insulating Varnishes.** *J. R. Lewis*, General Electric Company

CP.* **Heat Aging of Class Cloth Laminates.** *C. D. Doyle, H. T. Plant, L. S. Lazar*, General Electric Company

CP57-85. **Progress Report—Development of Test Methods for Thermal Stability of Varnished (Casted) Fabric Electrical Insulating Materials—Prepared by Task Force, Section V, Subcommittee VII, ASTM Committee D-9.** *L. E. Siefert*, Bureau of Ships; *H. K. Graves*, New York Naval Shipyard

CP.* **Thermal Stability of Flexible Sheet Insulation Using Wrapped Bar Method.** *R. L. Griffeth*, Mica Insulator Company

2:00 p.m. Transatlantic Cable

2:00 p.m. System Engineering, Computing Devices, and Transmission and Distribution

57-146. **Digital Computation of Driving Point and Transfer Impedances.** *H. W. Hale, J. B. Ward*, Purdue University

57-147. **Digital Solutions for Large Power Networks.** *R. J. Brown, W. F. Tinney*, U. S. Department of the Interior

CP57-148. **Tests and Experiences in the Use of Pulse-Type Electronic Fault Analyser on Transmission Lines.** *H. E. McCormack*, Appalachian Electric Power Company

57-149. **Some Features and Performance of Type C. Transmission Line Fault Locators.** *Y. Miyoshi, S. Saba*, Tokyo Shibaura Electric Company, Ltd.

THE WINTER GENERAL MEETING inspection trip to the East River Generating Station, Consolidated Edison Company of New York, will highlight the new 69 kv and 138 kv outdoor equipment as well as the newest generating units installed. The outdoor equipment and the newest portion of the station are visible in the foreground.

Courtesy Maurey Garber

THE CONTROL BOARD of the New York Coliseum will be seen during one of the Winter General Meeting inspection trips.

57-150. Analog Computer Representation of Alternators for Parallel Operations. *Luis Bofi*, Massachusetts Institute of Technology; *V. B. Haas, Jr.*, The University of Connecticut

2:00 p.m. Industrial Control

57-191. An Ignitron Contactor for Direct Press Drives. *D. L. Pettit, R. Montross*, Square D Company

CP.* A Dual Circuit Electronic Regulator. *J. J. Dailey, Jr.*, Reliance Electric and Manufacturing Company

57-4. Design and Calculation of Induction Heating Coils. *R. M. Baker*, Westinghouse Electric Corporation

CP57-192. Heat Conduction in the Coils of an Industrial Controller a Factor in Temperature Rise. *I. F. H. Douglas*, Marquette University

2:00 p.m. Solid State Dielectric Devices

CP.* Introduction: C. A. Rosen
CP.* Ferroelectric Devices: R. R. Delano, D. E. Mattiat, E. A. Sack
CP.* Electrophoto-Transducers: E. E. Loebner
CP.* Electrostatic Recording and Reproducing Devices: H. Epstein and G. R. Mott

2:00 p.m. Ethics

CP.* The ECPD Program in the Field of Professional Ethics. *C. T. Chase*, Stone and Webster Engineering Corporation

CP.* The NSPE Program in the Field of Professional Ethics. *E. K. Nicholson*, 1121 Banberry St., Bryn Mawr, Pa.

CP.* Attitudes and Ethical Values of Present Day Electrical Engineering Students. *D. S. Babb, M. S. Hohn*, University of Illinois

2:00 p.m. Industrial Power Systems

CP.* Load Dispatching in a Large Industrial Plant. *J. R. Eckert, J. M. Petruska*, Curtis-Wright Corporation

CP.* Acquiring a Modern Power Distribution System. *Tom Charles*, General Electric Company

CP.* Arrester and Capacitor Location on Industrial Power Systems. *A. Knable, D. Dalasta*, Allis-Chalmers Manufacturing Company

CP.* Operating Characteristics of High Capacity Air-Brake Contactors on Industrial Power Systems. *S. R. Durand, Thad Bellinger*, Allis-Chalmers Manufacturing Company

Photo by Fairchild Aerial Surveys, Inc.

DURING the Winter General Meeting, an inspection trip will be taken to the Bell Telephone Laboratories' installation at Murray Hill, N. J., where the latest contributions of science and technology are applied to Bell System communications. The country location, about 25 miles from New York, N. Y., was selected to escape the noise, dust, vibration, and electrical interference encountered in a metropolitan center.

Friday, January 2

9:30 a.m. Switchgear

57-180. New 13.8-Kv, 750-Mva Metal-Clad Switchgear with Magnetic-Type Power Circuit Breakers. *J. G. Torbit, E. M. Troischt*, General Electric Company

CP.* A New "De-Ion" Air Breaker for 750 Mva, 13.8 Kv. *Russell Frink, J. M. Koslovic*

57-181. A Motor-Powered Stored-Energy Operating Mechanism for Magnetic-Type Power Circuit Breakers in Metal-Clad Switchgear. *E. T. McCurry, J. A. Faure*, General Electric Company

CP.* A New 4.16-Kv, 75-Mva Air-Magnetic-Type Power Circuit Breaker in Metal-Clad Switchgear. *A. W. Simpson, L. D. Shaw*, General Electric Company

9:30 a.m. Protective Devices

CP57-23. Report on Lightning Arrester Applications for Stations and Substations. A report prepared by a Working Group of the Lightning Protective Devices Subcommittee of the AIEE Protective Devices Committee

57-52. Lightning Protection Practices at 220-Kv and 66-Kv Switching Structure of the Southern California Edison Company. *C. L. Sidway, B. R. Loxley*, Southern California Edison Company

57-42. Experience Revises Substation Lightning Protection. *E. H. Gehrig, R. S. Gens*, U. S. Department of the Interior, Bonneville Power Administration

CP57-110. Lightning Protection Practices of High Voltage Switching Structures on the Virginia Electric and Power Company System. *J. A. Rawls*, Virginia Electric and Power Company

9:30 a.m. Power Generation

9:30 a.m. System Engineering

57-45. The Effect of Interconnections on Economic Generation Expansion Patterns. *L. K. Kirchmayer, A. G. Mellor, H. O. Simmons, Jr.*, General Electric Company

57-151. Operations Research Determination of Generation Reserves. *E. L. Arnoff, J. C. Chambers*, Case Institute of Technology

57-152. Some New Mathematical Aspects of Fixed Charges. *C. W. Bary, W. T. Brown*, Philadelphia Electric Company

CP57-202. A New Approach to Loss Minimization in Electrical Power Systems. *J. F. Calvert, T. W. Sze*, The University of Pittsburgh

57-9. Survey of Arc Furnace Installations on Power Systems and Resulting Lamp Flicker. System Planning Subcommittee of the System Engineering Committee

9:30 a.m. Power and High Frequency Tubes

CP.* Trends in Power Electron Tube Design Techniques. *V. J. De Santis*, General Electric Company

CP57-86. A Series of Power Triodes Using Coaxial Terminal Construction. *C. V. Weden*, Machlett Laboratories, Inc.

CP.* Design of a Medium Power Ceramic Tetrode. *J. W. Kendall, Jr.*, Eitel-McCullough, Inc.

CP.* A Barkhausen Oscillator of the Resonant Cavity Type. *D. T. Davis, E. M. Boone*, Ohio State University

CP.* Development of a 30-Ampere Thyratron. *C. R. Wetter, A. M. Wohlert*, National Electronic Inc.

9:30 a.m. Dielectrics

CP.* Thermal Aging of Elongated Enameled Wire. *E. J. Croop*, Westinghouse Electric Corporation

CP.* End Points in the Thermal Aging of Magnet Wire. *W. W. Pendelton*, Anaconda Wire & Cable Company

CP.* Effect of Wire Material on Thermal Life of Enameled Magnet Wire. *J. Thomas, J. F. Dexter*, Dow Corning Corporation

CP.* Corona and Thermal Degradation on Magnet Wire. *M. C. Halleck*, General Electric Company

CP57-141. Thermal Stability of Laminated Thee-

mounting Plastics, I. *W. B. Kouwenhoven, G. G. Knickerbocker,* The Johns Hopkins University

9:30 a.m. Computing Devices

CP57-195. The Transistor Nor Circuit. *W. D. Rowe,* Westinghouse Electric Corporation.

57-196. The Transistor Nor Circuit Design. *W. D. Rowe, G. H. Royer,* Westinghouse Electric Corporation

CP.* The Transistor Nor Circuit Logic and Applications. *L. F. Stringer, W. D. Rowe,* Westinghouse Electric Corporation

CP*. The Nordic Computer. *W. D. Rowe,* Westinghouse Electric Corporation

CP.* The Arithmetic Design of the Nordic Computer. *T. A. Jeeves, W. D. Rowe,* Westinghouse Electric Corporation

9:30 a.m. Feedback Control Systems

57-204. A Study of the Transfer Function of Contact-Modulated Amplifiers. *F. H. Krantz,* Burroughs Corporation; *O. M. Salati, R. S. Berkowitz,* The Moore School of Electrical Engineering

57-182. A Quick Method for Estimating Closed-Loop Poles of Control Systems. *Kan Chen,* Westinghouse Electric Corporation

CP57-183. The Response of Relay Amplifiers with Feedback. *J. E. Gibson, F. B. Tuteur,* Yale University, Dunham Laboratory

57-201. Evaluation of Feedback Control Systems Subjected to Large Signals. *V. B. Haas*

57-184. A Two-Dimensional Feedback Control System. *Philip Sarachik, J. R. Ragazzini,* Columbia University

9:30 a.m. Applications in the Steel Industry

CP.* Magnetic Amplifier Arc Furnace Regulator. *E. J. Barreback,* Westinghouse Electric Corporation

57-55. Arc Furnace Corrective Equipment Using a High Value of Buffer Reactance. *H. W. Harper,* Northeastern Steel Corporation; *T. R. Macon,* General Electric Company; *A. F. Sedgwick,* United Illuminating Company

57-56. Selection of Buffer Reactors and Synchronous Condensers on Power Systems Supplying Arc Furnace Loads. *C. Concordia, L. G. Levoy,* General Electric Company; *C. H. Thomas,* University of Kansas

CP.* Static Switching Systems for the Steel Industry. *R. E. Manko,* General Electric Company

56-875. Modern Computer Analysis for the Design of Steel Mill Control Systems. *J. E. Reider, Philip Spergel,* Industrial Nucleonics Corporation. Represented for discussion only

9:30 a.m. Television and Aural Broadcasting Systems

CP.* Color Television Switching Systems. *Edward Pores,* National Broadcasting Company

CP.* Color Television Recording Employing Lenticular Film. *R. D. Kell,* Radio Corporation of America

CP.* Color Television Picture Reproducers. *P. C. Goldmark.* Columbia Broadcasting Systems Laboratories

2:00 p.m. Power Generation

2:00 p.m. Computing Devices

CP57-197. The A-C Network Analyzer Is an Asset in Teaching "Power" Courses. *P. E. Shields,* The Pennsylvania State University

CP.* Automatic Addressing for Random Access Memories. *W. W. Peterson,* University of Florida

CP.* Shift Register Decimal Counter. *J. A. O'Brien,* Bell Telephone Laboratories

CP.* The Transient Solution of Nonlinear Circuits on a Digital Computer. *J. C. Morgan,* International Business Machines Corporation

CP57-198. Biquinary Arithmetic. *Walter Brooks, Ivan Flores, Gregory Lasserson,* Nuclear Development Corporation of America

57-199. Shifting Counters. *C. Elders, H. J. Gray, Jr., H. M. Gurk, M. Rubinoff,* University of Pennsylvania, Moore School of Electrical Engineering. Represented for discussion

57-200. The Logical Design of a Digital Computer for a Large-Scale Real-Time Application. *M. M. Astrahan, B. Housman,* International Business Machines Corporation; *J. F. Jacobs, R. P. Mayer,* Massachusetts Institute of Technology; *W. H. Thomas,* International Business Machines Corporation

2:00 p.m. Electrical Techniques in Medicine and Biology

57-73. The Control of Air Ionization and Its Biological Effects. *W. W. Hicks, J. C. Beckett,* Wesix Electric Heater Company

CP.* Standards for Measurement of Brightness Intensification in Fluoroscopic Image Intensifiers. *W. S. Lusby,* Westinghouse Electric Corporation

CP.* Remote Stimulation of Cortical Areas in Primates. *G. C. Riggle, G. I. Johnston,* National Institute of Health

2:00 p.m. Feedback Control Systems

CP57-185. A New Stability Criterion of Linear Servomechanisms by a Graphical Method. *Toshio Numakura, T. Miura,* Hitachi Central Research Laboratory, Kokubunji, Tokyo, Japan

57-186. Transfer Matrix Stability Criterion Applied to an Amplidyne Servo Network. *P. M. Honnell, D. Wolfenstein,* Washington University

57-41. Noninteracting Controls in Linear Multivariable Systems. *R. J. Kavanagh,* University of Toronto

57-44. A Synthesis Method for Multipole Control Systems. *H. Freeman,* Sperry Gyroscope Company

57-187. Compensation of an Error-Sampled System by a Multirate Controller. *G. M. Krane,* Columbia University

2:00 p.m. Television Equipment Developments

CP.* Television Translators and Satellites. *Benjamin Adler,* Adler Communications Laboratories

CP.* Transistorized Television Cameras Using the Miniature Vidicon. *L. E. Flory,* Radio Corporation of America Laboratories

CP.* Control of Radiation from FM and TV Receivers. *R. J. Farber,* Haseltine Research Corporation

CP.* Automatic Program Control for Television Broadcasting. *A. C. Angus,* General Electric Company

2:00 p.m. Communication Switching Systems

57-47. The Automatic Line Concentrator and Subscriber Telephone Applications. *H. G. Evers, J. R. Wylie,* Leich Electric Company

CP.* Optimal Utilization and Expansion of Inter Office Trunking Facilities. *R. E. Kalaba, M. L. Juncosa,* The Rand Corporation

57-105. A New Family of Transistor Switching Circuits. *Morris Rubinoff,* University of Pennsylvania

57-106. Transistor Two-Terminal Switches.

77 Papers Presented at Conference on Magnetism and Magnetic Materials

THE SECOND NATIONAL Conference on Magnetism and Magnetic Materials, sponsored by the AIEE in co-operation with the American Physical Society, the American Institute of Mining, Metallurgical and Petroleum Engineers, and the Institute of Radio Engineers, was held October 16-18, 1956, at the Hotel Statler, Boston, Mass.

Paid registrations for the conference numbered 749 and the total registration (including Magnetics Exhibit) was 1,096. The number of companies participating in the exhibit was 15.

Technical Sessions

The total number of papers presented was 77. During one of the sessions, W. H. Meiklejohn announced a new magnetic anisotropy called "Exchange Anisotropy." This anisotropy is the result of an interaction between an antiferromagnetic material and a ferromagnetic material. A material that exhibits this exchange anisotropy is cobalt in fine particles with a cobaltous oxide shell. Above the Néel temperature of the cobalt oxide, the magnetic properties are as expected for pure cobalt particles. Below the Néel temperature, there exists an interaction between the spins of the ferromagnetic cobalt and the antiferromagnetic oxide. This interaction gives rise to unidirectional anisotropy in that it produces one easy direction of magnetization, thus, the torque curve is proportional to sin θ rather than sin 2θ as in pure cobalt. In addition, both the coercive and the residual flux density become asymmetrical along the axis of magnetization. Experimental values of 2,200-oersteds loop displacement, giving rise to a 5,400-oersteds coercive force have been obtained for the cobalt–cobalt oxide particles. Thus, this new magnetic anisotropy is of sufficient magnitude to effect substantially the coercive force of single domain particles, providing another approach to development of a fine particle magnet.

Unique magnetic domain patterns of thin films were shown in a movie presented by R. C. Sherwood of the Bell Telephone Laboratories. The character of the domain particles was shown to be dependent on the thickness of the film rather than its composition.

Robert Campbell from the Franklin Institute Laboratories discussed the magnetic properties of elongated iron oxide particles, and their crystallite orientation as obtained from selected area electron diffraction. The predicted value of coercivity is lowest and agrees best with experiment when the whole distribution of particles sizes and shapes is considered rather than the median, and also when the contribution of superparamagnetic and multidomain particles is considered.

The properties of the Alnico permanent magnet alloys were reproduced with elongated single domain cobalt iron particles as described by F. E. Luborsky from the General Electric (GE) Measurements Laboratory. Compacting these particles with various degrees of alignment and packing density, shape anisotropy fine-particle magnets have been made with magnetic properties duplicating those of each of the Alnico permanent magnet alloys, including maximum energy product values above 5 million gauss-oersteds. It was concluded that the Alnico alloys and the cobalt-iron fine-particle magnets derive their permanent magnet properties from very similar shape anisotropy effects. It was pointed out

that further improvements can be expected from better particle alignment, shape, distribution and composition. Thus, the fine particle approach to permanent magnet development continues to the a most promising area of research.

I. S. Jacobs of the GE Research Laboratory reported on his study of various aspects of the magnetic anisotropy of electrodeposited elongated single domain iron and cobalt-iron particles. Calculations of the rotational hysteresis in single domain particles were extended to the chain-of-spheres model. This rotational hysteresis enables a relatively sensitive choice between several models of the magnetization process. The experimental results suggest a slightly greater anisotropy than predicted by the chain-of-spheres model. Thus, the theoretical analysis of the magnetic properties of these elongated single-domain particles appears to be on a firm foundation.

A surprise was produced by Dr. K. J. de Vos from the Philips Metallurgical Laboratories in the Netherlands, in his paper entitled "A Contribution to the Study of Permanent Magnets of the Fe-Co-Ni-Al Type." He announced the preparation of magnets of the Alnico type with magnetic energies of 10 and 11 million gauss-oersteds —a world record. Some years ago, the English had prepared directional grain Alnico type alloys with energies up to 8.3 million gauss-oersteds. This had been the world's record until this announcement. To achieve the unique improvement a study was made of the cause of the coercive force in these alloys. This study comprised an investigation of the phase relations in these alloys as well as an extensive analysis of the heat treatment. Alloys with more than twice the coercive force of the Alnico V were prepared by using a high cobalt alloy and by the addition of titanium. The excellent crystallite orientation was achieved by using crystal pulling techniques as used in the semiconductor field. It appears from this work that we still have no more than scratched the surface in permanent magnet alloy development.

Additional insight into the properties of Alnico V were obtained from nucleation experiments by E. A. Nesbitt and A. J. Williams of the Bell Telephone Laboratories. They found that the heat treatment in a magnetic field was effective only when applied during the range of thermal nucleation of the precipitate.

The processing and properties of the unique cobalt-platinum permanent magnet alloy were described by D. L. Martin of the GE Research Laboratory. Coercive force values of 4,700 oersteds and energy product values of 9 million gauss-oersteds have been obtained by controlled cooling and ordering. The study of cobalt platinum alloys is of special scientific interest because these alloys represent a different kind of permanent magnet material than Alnico. The reaction is an order-disorder transformation rather than a precipitation.

The magnetostriction of the ordered and disordered iron-platinum alloys was correlated with structural changes by E. Klokholm from the Franklin Institute Laboratories.

The neutron diffraction study by B. W. Roberts on manganese bismuth has clarified the structural transformations occurring in this high crystal anistropy compound. In the temperature range of 350-445 C, a disordered structure fits the data well if the Mn atoms are assumed to be in the paramagnetic state. This model conflicts with the suggestion made by Guilland of an antiferromagnetic state in this temperature range. Observation on spin orientation directions made at temperatures below 84 K show only partial moment rotation in zero applied magnetic field.

Neutron diffraction was also used by R. Nathans of Pennsylvania State University to determine the magnetic moments of Fe_3Al. These iron and aluminum alloys received considerable attention from Westinghouse Research Laboratories.

R. E. S. Walters from Post Office Engineering Department, London, England, discussed an investigation to determine the extent to which the magnetic behavior of nickel-iron alloys can be interpreted in terms of ordering. The initial permeability of Ni_3Fe depended critically on the temperature from which it was quenched, the optimum temperature being 600 C. It was suggested that just as in the supermalloy-type alloys, maximum permeability is associated with a critical degree of long-range order. Curves of resistance versus temperature show that addition of molybdenum to nickel-iron alloys promotes long-range ordering.

The growth of cobalt particles in copper was followed in the range from 12 to 70 Angstrom units by a new technique. The method is based on the calculation of the magnetic moment of the individual particles from the magnetization curves.

The paramagnetic behavior of particles in this extremely small size range was confirmed by the fact that their magnetic curves at different temperatures superpose perfectly when plotted H/T. The presence of a ferromagnetically "dead" surface layer, devoid of ferromagnetic coupling, has frequently been postulated. A comparison of particle size with saturation in these experiments indicates that no such layer is present. Thus, this technique is useful for the determination of particle size in the range below that obtainable from the electron microscope.

W. E. Bell from Varian Associates described a new technique which is useful for the measurement of magnetoresistance phenomena in conductors or nonconductors. This apparatus measures the radio-frequency absorption as a function of magnetic field and, therefore, is described by the term "magnetoabsorption." Sensitivities of one part in one million are obtainable. This apparatus was used to observe magnetoabsorption effects in a number of paramagnetic systems. The high resolution and variable skin depths offered by the radio frequency detection field permit studies of strain, grain orientation, and oxidation.

A simple method to calculate leakage factors for magnetic circuits with permanent magnets was discussed by R. K. Tenzer from the Indiana Steel Products Company. Deviations from measured values were less than 6 per cent.

A GENERAL VIEW of the audience (above, *left*) attending one of the technical sessions held during the Conference on Magnetism and Magnetic Materials, October 16-18, 1956, Hotel Statler, Boston, Mass. Informally discussing three major achievements in magnetic research are (above, *right; left to right*) Dr. W. H. Meiklejohn, General Electric (GE) Research Laboratory, who discovered a new "Exchange Interaction" between ferromagnetic and antiferromagnetic materials; Dr. T. O. Paine, GE Measurements Laboratory, who described the development of fine particle cobalt-iron permanent magnets with properties comparable to the Alnicos; and Dr. K. J. de Vos, Philips Metallurgical Laboratories, the Netherlands, who disclosed development of an 11 million gauss-oersteds energy Alnico Magnet—the highest energy ever achieved.

A new ferroresonance combination for static control devices was described by A. T. Balint from the University of Buffalo. His method consists of nonlinearly combining a pair of dissimilar ferromagnetic elements with a condenser of predetermined value in a differential transformer in order to obtain the stabilized secondary voltage.

A number of other specific instruments were described. For example, an automatic torque balance for the determination of magnetocrystalline anisotropy, a d-c hysteresigraph, a power comparing calorimeter, instrumentation for magnetic and hysteresis curve measurements, instrumentation for magnetostriction at low alternating field intensities.

G. W. Weiner of Westinghouse Electric Corporation, described experiments on the effect of impurities and orientation on the losses in silicon iron. These two factors could be studied independently of each other. The major effect of the impurities on the d-c magnetic properties was to decrease the remanence, increase the coercive force, decrease the maximum permeability, and increase significantly the field required to reach 15 kilogauss. The effect of orientation on the d-c properties was to decrease the remanence, increase the field required to reach 15 kilogauss, and decrease the maximum permeability. The hysteresis loss was a function of orientation, increasing with decreasing degree of perfection. This is one of the few examples of the clear indication of the structural dependence of the a-c losses.

Techniques have been developed by P. Albert of Westinghouse Electric Corporation for the production of both discrete etch pits and domain patterns on polished surfaces of aluminum iron alloys. This has been found useful for the rapid evaluation of degree of preferred orientation in these alloys, particularly in the large grain size ranges, where X-ray techniques are not suitable.

Two new magnetic materials were described in the session on soft magnetic materials. Supermendur, a new rectangular loop material with high flux density and low coercive force was described by H. B. Gould of the Bell Telephone Laboratories —maximum permeability at 20,000 gauss was 66,000; remanence of 21,150; and a coercive force of 0.26 oersted. In contrast to other iron cobalt alloys, supermendur possesses unusual malleability which permits cold reductions of over 99 per cent, making it available in strip, a few thousandths of an inch thick. Thus, this material promises to be of value in telephone receiver diaphragms, miniaturization, high temperature operations, and switching and memory devices.

Sendustflake, a new magnetic material for low frequency application, was developed in the U. S. Naval Ordnance Laboratory. Low loss cores were prepared by compacting Sendustflakes, which were prepared by warm rolling Sendust powder. The improved magnetic properties of the new flake cores make them an attractive nonstrategic substitute for applications which now require powdered high nickel alloys. Permeability values measured on these cores ranged from 150-230 with electrical losses as low as present powder cores.

A single sheet tester was proposed by Peter Neurath for evaluation of high quality magnetic strip materials to replace the standard Epstein test. The new test is faster, very simple, and more reliable.

New magnetic core materials for use at frequencies up to the uhf band were described by H. P. Wijn of the Philips Research Laboratories in the Netherlands.

The growth of ferrite single crystals was discussed in some detail by W. G. Field of the Air Force Cambridge Research Center. Best results were obtained from the flame fusion method.

A new process for preparing ferrites was announced by J. F. Wenckus of the Lincoln Laboratories of Massachusetts Institute of Technology. The technique involves the preparation of alcohol solutions of various metallic nitrates to produce a feed solution of the desired stoichiometry, atomizing with oxygen through a nozzle and igniting. The products of combustion are extremely fine ferrite powders having the desired spinel structure, water vapor, and various gases.

The ferrite accelerating cavities for the 25 billion electron volt synchrotron are fabricated from some of the largest ferrite rings ever made. M. Plotkin from the Brookhaven National Laboratories described the characteristics and properties of this high performance ferrite cavity.

A new Faraday rotation phenomenon has been applied to microwave switching by J. A. Weiss of the Bell Telephone Laboratories.

The production and use of magnetic fields up to 750,000 oersteds was described by Simon Foner of the Lincoln Laboratories. Pulsed field measurements of galvanomagnetic effects in semiconductors, antiferromagnetic resonance at 4 mm wavelength, and cyclotron resonance were used to illustrate the capabilities and limitations of this technique.

The crossed field magnetic amplifier was described by E. H. Frei of the Weizmann Institute of Science in Israel. With no mutual inductance between exciting and output coils direct coupling is avoided. Using this amplifier a clip-on d-c milliammeter and a static reproducing head was designed. The behavior of this type of amplifier was analyzed.

The ferrite bead—a new memory device—is capable of automatic production, low current drive, high output voltage, and fast switching time. The ferrite powders are fired directly on fine wires to form ellipsoidal beads about 1-mm long. Thus, this device is ideally suited for use in large high speed computers. This work was described by D. H. Looney of the Bell Telephone Laboratories.

SESSION CHAIRMEN discussing the display of one of many fine exhibits shown by several leading manufacturers of magnetic materials or associated equipment during the Magnetics Exhibit held in conjunction with the Conference on Magnetism and Magnetic Materials are *(left to right)* G. T. Rado, R. M. Bozorth, J. Osborn, J. E. Goldman, T. O. Paine, W. Hibbard, and V. C. Wilson.

Last Call for Subscriptions to Volume 75 of 1956 AIEE Transactions

VOLUME 75 of the 1956 AIEE *Transactions*, bound in cloth with gold embossed lettering will be made available during March and April in three parts as follows: Part I. Communication and Electronics, Part II. Applications and Industry, Part III. Power Apparatus and Systems.

Each of these parts contains the papers officially approved by the technical committees collated with the discussions and the authors' closures, if any, which were presented during the calendar year. Each part is separately indexed by title on a multientry basis as well as by authors. All three parts contain over 550 papers and approximately 2,900 pages.

The member combination subscription to all three parts is $9, or $3 to any individual

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Discounts of 25 per cent of the nonmember prices mentioned are allowed to college and public libraries. Publishers and subscription agencies are allowed 15 per cent discount of the nonmember prices quoted. Please send all orders and remittances to: Order Department, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y.

These volumes, bound in cloth, afford an excellent opportunity to start or enlarge a library. Volume 75 will be made available during March and April but the receipt of orders now is essential to assure receiving the volume of Transactions while the supply lasts.

Western Joint Computer Conference Is Scheduled for February 26-28, 1957

THE 1957 Western Joint Computer Conference will be held at the Hotel Statler, Los Angeles, Calif., February 26-28, 1957. The conference will be under the joint sponsorship of the AIEE, the Institute of Radio Engineers (IRE), and the Association for Computing Machinery (ACM). The theme of the meeting will be "Techniques for Reliability."

Inspection trips held during the conference will include visits to Jet Propulsion Laboratory, Electro Data Corporation, Ramo-Wooldridge Corporation, University of California at Los Angeles, Telemeter Magnetics, Inc., Litton Industries, Rand Corporation, and National Cash Register Company.

Women's Activities will include trips to motion picture and television studios and other interesting places.

A conference cocktail party will take place Tuesday evening, February 26, at the Hotel Statler. The conference luncheon is scheduled for Thursday afternon, February 28, at the hotel.

The Los Angeles Chapter of the ACM is sponsoring a symposium on Friday, March 1, at the Hotel Statler in Los Angeles, Calif. The subject of the symposium will be "New Computers—A Report from the Manufacturers." It is probable that the people attending the Western Joint Computer Conference would like to stay over and attend this related event.

Symposium Officers and Chairmen

SOME OF THE OFFICERS and sponsoring group chairmen for the third National Symposium on Reliability and Quality Control, January 14-16, 1957, Washington, D.C., are (*left to right*) C. M. Ryerson, Radio Corporation of America (RCA), Symposium program chairman; A. B. Mundel, Sonotone Corporation, chairman, Electronic Division, American Society for Quality Control; Victor Wouk, Beta Division, Sorenson and Company, chairman, Professional Group on Reliability and Quality Control of the Institute of Radio Engineers; M. M. Tall, RCA, chairman, third and fourth National Symposiums; and V. Harriss, Vitro Corporation, chairman, Subcommittee on Reliability and Quality Control of the Electronics Committee of AIEE.

The tentative technical program for the Western Joint Computer Conference follows.

Tuesday, February 26

Morning

Registration

Welcome: J. L. Barnes, System Laboratories Corporation, Conference chairman

Keynote Speaker: J. H. Bridges, Chief of Electronics, Office of the Assistant Secretary of Defense

Afternoon

Session I. Mathematics of Reliability

Mathematics of Reliability. *Boldyreff*, Rand Corporation

Design of Experiments. *John Hofmann*, System Laboratories

On Prediction of System Performance from Information on Component Performance. *J. R. Rosenblatt*, National Bureau of Standards

Evaluation of Failure Data. *H. I. Zagor*, Arma Division, American Bosch Arma Corporation

Session II. New Systems A

A Digital System Simulator. *W. E. Smith*, Aeronutronic Systems, Inc.

Factors Influencing the Design of the New High Speed Input-Output System for the Florida Automatic Computer (FLAC). *C. F. Sumner*, RCA Service Co.

The IBM RAMAC System—Memory Unit Operation. *D. Royse*, International Business Machines

The IBM RAMAC System—Inquiry Station Operation. *H. A. Reitfort*, International Business Machines

Wednesday, February 27

Morning

Session III. Applications

Reliability in Business Systems. *H. T. Glantz*, John Diebold and Associates

Panel Discussion: A Report from the Users

Session IV. New Components

An RCA High Performance Tape Transport System. *S. Bayblick, R. E. Montijo*, Radio Corporation of America

A Medium Speed Magnetic Core Memory. *G. E. Valenty*, Remington Rand UNIVAC

Millimicrosecond Transistor Switching Techniques. *E. J. Slobodzinski, H. S. Yourke*, IBM Research Center

New High Magnetic Phenomena. *E. L. Newhouse*, Radio Corporation of America

Afternoon

Session V. Component Reliability

Packaging Techniques. *W. E. Dombart*, Burroughs Corporation

Accuracy Control Systems for Magnetic Core Memories. *A. Katz, A. G. Jones, G. Reset*, Radio Corporation of America

Design of a Basic Computer Building Block. *J. Alman, P. Phipps, D. Wilson*, Remington Rand UNIVAC

Error Detection in Redundant Systems. *S. Schneider, D. H. Wagner*, Burroughs Research Center

Session VI. Analog Computer Equipment

Analog Logarithmic and Antilogarithmic Circuits Using Switching Transistors. *A. J. Schiewe, K. Chen*, Westinghouse Electric Corporation

High Speed Digital-to-Analog Conversion by Integration of a Variable Rate Pulse Train. *A. D. Glick*, Minneapolis-Honeywell Regulator Company

A Reliable Method of Drift Stabilization and Error Detection in Large-Scale Analog Computers. *E. E. Eddey*, Goodyear Aircraft Corporation

A New Method of Verifying Analog Computer Problems and Performances. *W. C. Mellander*, Goodyear Aircraft Corporation

Thursday, February 28

Morning

Session VII. Programming for Reliability

Diagnostic Techniques Improve Reliability. *Grems, Smith, Stadler*, Boeing Airplane Company

Error Detection and Error Correction in Real Time Digital Computers. *A. Ralston*, Bell Telephone Laboratories

The FORTRAN Automatic Coding System, Description and Users' Reports. International Business Machines

Session VIII. New Systems B

The Lincoln *TX-2* System
Lincoln Laboratory, Massachusetts Institute of Technology

The Lincoln *TX-2* Computer. *W. A. Clark*

Functional Description of the *TX-2*. *J. M. Frankovitch*

The *TX-2* Input-Output System. *J. W. Forgie*

Memory Units of the *TX-2*. *R. L. Best*

Standardized Circuitry of the *TX-2*. *K. H. Olsen*

Afternoon

Session IX. Systems Reliability

The Interpretation and Attainment of Reliability in Industrial Data Systems. *B. K. Smith*, Beckman Instruments, Inc.

Accuracy Control in the RCA BIZMAC System. *I. Cohen, J. G. Smith, A. M. Spielberg*

Continuous Computer Operational Reliability. *R. D. Brinkman*, United States Army

Field Performance of a New Automatic Fault Locating Means. *J. F. Scully, L. P. Colangelo*, Rome Air Development Center

Session X. Programming

The Variable Word and Record Length Problem and the Combined Record Approach on Electronic Data Processing Systems. *N. J. Dean*, Ramo-Wooldridge Corporation

The RCA BIZMAC Sorter. *B. Adler, H. P. Guerber, J. C. Hammerton, J. F. Page*, Radio Corporation of America

Empirical Exploration of the Logic Theory Machine. *A. Newell, J. C. Shaw, H. A. Simon*, The Rand Corporation

Programming the Logic Theory Machine. *A. Newell, J. C. Shaw*, The Rand Corporation

Citation Award Highlights Conference on Machine Tools

THE AIEE CONFERENCE on Machine Tools was held in Cincinnati, Ohio, October 22-24, 1956. "This Eighth Annual Conference was most successful," reports Chairman R. E. Stroppel, plant engineer, Tool Steel Gear & Pinion Company, Cincinnati, Ohio. The attendance was 692. Although this was almost identical to the 1954 attendance of 691 in Detroit, Mich., it was, in reality, a significant increase since the local registration from Cincinnati totalled only 100 while the Detroit local registration totalled 200.

The meeting drew 1 representative from England, 3 from Canada, 10 from the West Coast, as well as most of the major industrial areas in the United States.

At most conferences of this sort, there is usually a considerable crowd milling around in the lobby while the meetings are in progress. This year it was noticed that the only people not actually attending the meeting were those who were taking care of details such as registrations, sale of tickets, etc.

No meeting was held in 1955 because of the conflict with the National Machine Tool Show. At that show, many new machines and new controls were displayed.

This AIEE Meeting in 1956 presented highly technical control information having to do with the new machines first announced in 1955. This timing proved very advantageous.

The success of the meeting was made evident by the many fine comments from the gentlemen who attended, representing many branches of the industry. Those not closely associated with the new developments were amazed to learn of the progress which had been made. The speakers and subjects were as follows: "The Attack on the Manpower Shortage," H. K. Justice, assistant dean of engineering, University of Cincinnati; "The Machine Tool Industry Viewpoint," Louis Polk, president, National Machine Tool Builders Association; "Wiring Automatic Machinery with Maintenance as a Factor," R. N. Johnson, Electrical Control Division, W. F. & John Barnes Co.; "Latest Revision of Machine Tool Electrical Standards," E. J. Loeffler, chairman, Electrical Standards Committee, National Machine Tool Builders Association; "The Co-operative System as a Contribution to the American Way of Life," Dr. Walter Langsam, president, University of Cincinnati; "A General View of Numerical Controls," Ralph Schuman, Warner & Swasey Co., Cincinnati, Ohio; "Computer Elements Available for Machine Tool Use," G. F. Baldwin, General Electric Company, and H. Tholstrup, Commercial Controls Corp.; "Potential of Numerical Control in the Aircraft Industry," K. C. Wood, Boeing Airplane Company; "Programming for the Giddings and Lewis Numericord System," K. S. Jensen, Giddings & Lewis Machine Tool Co.; "The Possible Impact of Numerical Control on Industry," Dr. L. T. Rader, general manager, specialty control department, General Electric Co.; "Precise Positioning with Numerical Control," E. E. Kirkham, Pratt & Whitney Company; "The Numill, A Numerically Controlled Machine for Two-Dimensional Parts," J. L. Bower, Autonetics, Division of North American Aviation Co.; "Digimatic, The ESC Con-

KLT Photos

AMONG THOSE ATTENDING the Banquet (above) held during the AIEE Conference on Machine Tools were *(left to right)* R. H. Clark, past chairman of the Subcommittee on Machine Tools; E. J. Loeffler, chairman, Electrical Standards Committee, National Machine Tool Builders Association; L. T. Rader, general manager, specialty control department, General Electric Company; R. E. Stroppel, general chairman of the conference; Don Michael, chairman of the Cincinnati Section; and R. S. Gardner, AIEE Headquarters. A feature of the conference *(right)* was the presentation of a citation to Tell Berna, executive vice-president of the National Machine Tool Builders Association. Some of those at the presentation were *(left to right)* Mr. Michael, B. F. Bennett, Mr. Clark, J. I. Ehrhardt, and Mr. Berna.

touring System for Machine Tools," Jack Rosenberg, Electronic Control Systems, Inc.; "The Bendix Numerical Control System," R. G. Sims, Bendix Aviation Corp.; "The Cincinnati Numerical Control System," H. M. Fuldner and J. W. Wilson, Cincinnati Milling Machine Co.; "Where Do We Go From Here?" Tell Berna, general manager, National Machine Tool Builders Association.

One of the highlights of the meeting was the presentation to Tell Berna, executive vice-president of the National Machine Tool Builders Association of a citation for his work in fostering progress in the electrification of machine tools. The citation read:

> "The Subcommittee on Machine Tools of the American Institute of Electrical Engineers awards this certificate to Tell Berna, Business Statesman, Salesman and Engineer; Leader in creating and maintaining the climate and driving force in American industry which fosters rapid and orderly progress in the electrification of machine tools; For participation and contribution to the activities of the Subcommittee."

The citation was presented for the Subcommittee by R. H. Clark, director of organization development of the Warner and Swasey Company, Cleveland, Ohio, and past chairman of the Subcommittee.

Hosts for plant visitation were the Allis-Chalmers Manufacturing Company, The G. A. Gray Company, and the Cincinnati Milling Machine Company.

Chairman Stroppel wishes to express his sincere appreciation to the Local Cincinnati Committee for its excellent spirit.

Preliminary Architectural Plans Begun for New Engineering Center

United Engineering Trustees, Inc., the joint corporate agency of the four major national engineering societies, has signed a contract for preliminary architectural plans and studies for a new Engineering Center in mid-Manhattan, New York, N. Y. This is the first definite step toward construction of what is expected to make New York the "engineering capital of the world."

Announcement of the granting of the contract came with announcement of the re-election of W. J. Barrett, of Glen Ridge, N. J., as president of United Engineering Trustees, Inc. (UET). It was, also, the first formal revelation that all the four member societies of UET, and a fifth that is expected to become a member, had voted, through their governing boards, to remain in New York. Several other cities had endeavored to obtain the Center.

The architects named are Shreve, Lamb and Harmon Associates, of 11 E. 44th St., New York, N. Y., designers of the Empire State Building and more recently the new Brooklyn Supreme Court Building. The announcement did not indicate any details as to specific location, cost, or time of completion.

The present 16-story quarters, known as the Engineering Societies Building, house the four "Founder Societies," the AIEE, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, and The American Society of Mechanical Engineers. A fifth prospective "Founder Society," the American Institute of Chemical Engineers (AIChE) will be included in the Center project. At a recent meeting at which Mr. Barrett was re-elected and the architectural contract granted, the Board of Trustees of UET approved the AIChE as a member. This action awaits ratification of the other four Societies.

The AIChE now is located at 25 W. 45th St. Occupants of the Engineering Societies Building include Engineers Joint Council, which is composed of 10 major national engineering societies, including the five in the "Founder" group.

It is believed that preliminary plans will be completed early in 1957. The inclination toward a mid-Manhattan site is due to appreciation of accessibility of railroad and airline terminals and convention hotels.

Financing is expected to run into "several million dollars." In addition to the contributions of the various "Founder Societies" and their members, UET, which has been charged with the responsibility of the planning, construction, and financing of the new structure, has received assurances of the cooperation of a group of industrialists and educators toward the required fund. This group, headed by Dr. M. J. Kelly, president of Bell Telephone Laboratories, Inc., stated on June 8, 1955, in a letter to UET and its constituent societies, its readiness to assist in this direction on the selection of a city following a broad and careful study of all possible sites with national rather than local interests to be the determining factor.

Mr. Barrett was elected president of UET last year when the new Center project had reached a high state of discussion. His re-election continues his direction of the biggest program of UET since it was created in 1904, at which time Andrew Carnegie presented the present Engineering Societies Building as a suitable union home for the profession. Mr. Barrett is transmission maintenance engineer of the New Jersey Bell Telephone Company, Newark, N. J. He represents the AIEE on the UET Board of Trustees and is treasurer and a director of the Institute. He is also a director of Engineers Joint Council.

In a statement announcing the granting of the contract, Mr. Barrett said:

"It is the consensus of UET that the new Engineering Center presents a challenge to the profession. Engineers have planned, designed, and constructed outstanding structures of all kinds throughout the world. Now the profession faces the challenge of building for itself a Center that will reflect the profession's dignity and stature. It is not likely that the genius and imagination that have gone into the building and rebuilding of the modern world will fail to create in this instance an appropriate testimonial to the profession's achievements.

"The new Engineering Societies Building will, as is true of the present quarters, contain more engineering organizations than any other building in this country. It will have, indeed, more than any other building in the world. Our present quarters have been crowded for years. As memberships and activities have expanded the need for greater space has become increasingly pressing. The new Center will make possible its occupancy by societies not able now to find space in the present quarters.

"UET was established 52 years ago 'to advance the engineering arts and sciences in all their branches and to maintain a free public engineering library.' It owns the Engineering Societies Building. Through the Engineering Foundation, it conducts research in engineering and scientific subjects for the advancement of engineering and for the good of mankind. The library is the largest of its kind in this country and works closely with the New York Public Library, the Library of Congress, and other institutions. UET acts in a fiduciary capacity for a large number of joint activities of the major engineering societies.

"As it became evident in recent years that the present quarters were inadequate, many cities pressed to have the new Center located in their communities. All these were given full consideration. A Special Task Committee of Fifteen, three from each of the five societies directly concerned, directed a study by an independent firm of management consultants and this Committee several months ago made recommendations which were presented to the governing boards of the five Societies. The governing boards have voted to approve the recommendation to remain in New York."

The June 8, 1955, letter, signed by 21 men eminent in their fields of industry, engineering, science, and education, gave assurances, in the matter of financing the new Center, that "a well-organized, diligent, and competent effort will be made and continued until the required sum is available." The letter urged the designation of independent management consultants to make a thorough-going study of all considerations in the offers and invitations of the several cities. The letter emphasized that "we are agreed that the fundamental desirability of approaching this matter on a national rather than a local basis transcends our personal preferences." The letter said further:

"The progress of our highly industrialized society is dependent on its scientific and technologic strength. A major portion of the technology upon which our industries depend is encompassed within the combined scope of your Societies, and a large portion of the professional men contributing to the technology and its practice are members of one or more of your organizations. It is because of the important place in our society that you occupy that we are concerning ourselves with the choice of a location for your new headquarters."

The signers stated that "the long-range interests of the Societies in serving their professions and the nation are paramount" and that "maximum effectiveness of your operations is of controlling importance."

The letter went on to say: "Most industries of the country benefit directly from the technologies included in your organizations. We are sure they will contribute generously to your building funds if your location is chosen on the broad-gauged basis suggested. If such a choice is made, a group of the undersigned will organize a large national committee, representing all sections, all technologies in your Societies, and a variety of industries, to conduct a nation-wide drive for funds."

Besides Dr. Kelly, the signers were: J. F. Bell, Minneapolis, Minn., chairman, Committee on Finance and Technological Progress, General Mills, Inc; D. W. Bronk, Washington, D. C., president, National Academy of Sciences; R. J. Cordiner, New York, N. Y., president, General Electric Company; James Creese, Philadelphia, Pa., president, Drexel Institute of Technology; J. H. Davis, Hoboken, N. J., president, Stevens Institute of Technology; L. A. Du Bridge, Pasadena, Calif., president, California Institute of Technology; T. K. Glennan, Cleveland, Ohio, president, Case Institute of Technology; E. G. Grace, New York, N. Y., chairman of the Board, Bethlehem Steel Corporation; C. H. Greenewalt, Wilmington, Del., president, E. I. du Pont de Nemours & Co. (Inc.); W. H. Harrison (since deceased), New York, N. Y., president, International Telephone and Telegraph Corporation.

Other signers were: L. W. Houston, Troy, N. Y., president, Rensselaer Polytechnic Institute; F. L. Hovde, Lafayette, Ind., president, Purdue University; K. T. Keller, Detroit, Mich., chairman of the Board, Chrysler Corporation; H. P. Liversidge (since deceased), Philadelphia, Pa., chairman of the Board, Philadelphia Electric Company; J. L. McCaffrey, Chicago, Ill., president, International Harvester Company; A. P. Sloan, Jr., New York, N. Y., chairman of the Board of Directors, General Motors Corporation; C. A. Thomas, St. Louis, Mo., president, Monsanto Chemical Company; M. D. Whitaker, Bethlehem, Pa., president, Lehigh University; R. E. Wilson, Chicago, Ill., chairman of the Board, Standard Oil Company of Indiana; J. D. Wright, Cleveland, Ohio, president, Thompson Products, Inc.

McKinsey & Company, management consultants, surveyed all factors involved in the possibilities advanced by the several cities and recommended New York, N. Y. In a report on June 22, 1956, forwarded to the governing boards of the Societies, the Special Task Committee of Fifteen reviewed the considerations involved and urged that midtown New York be approved.

It was suggested that if the present site proved to be not feasible another location in midtown be chosen. The proposal required approval of each of the Societies. The final approval was voted recently.

Besides Mr. Barrett, officers elected by UET for the next year are: 1st Vice-president, W. F. Thompson (vice-president, Westcott & Mapes, Inc.); 2nd Vice-President, Andrew Fletcher (president, St. Joseph Lead Company); Treasurer, J. L. Kopf (president, Jabez Burns & Sons, Inc.); and Assistant Treasurer, G. W. Burpee (Partner, Coverdale & Colpitts).

ESPS Wants To Know Do the Oldsters Want Jobs?

W. N. CAREY

ARE THERE MANY OR FEW retired engineers, or others past 50, able and willing to take temporary jobs in engineering? Engineering Societies Personnel Service (ESPS), the employment agency for the engineering societies, wants to know. The Board of Directors of ESPS has asked me to pose the question. Being on the retired list myself, both from the U. S. Army and from active professional work, and having served as a member and chairman of the Board of ESPS, the question seems to me well worth trying to answer.

The current shortage of engineers and scientists is a well-known fact. Continuous advertising in the newspapers of metropolitan areas and the quarterly combing of our campuses emphasize the need for young engineers and scientists. The supply does not begin to meet the demand for young men in these fields. Is the shortage confined to the young men, or does it include men in the older brackets in industry and Government? Is it possible partially to meet today's need for engineers and scientists by temporary employment of men no longer young but willing and able to perform the required tasks? If such men are available and employers want them as temporary help, the task of trying to get employers and prospective employees together will be undertaken by ESPS.

It is realized, of course, that there are deterrents and complications in any attempt to employ older or retired engineers even temporarily on routine work. Some of the largest companies, whose engineer recruitment efforts are the most impressive, simply will not hire engineers or scientists over 55. Their reasons are sound where permanency in an organization is envisaged. But temporary, day-by-day or week-by-week employment of men to help level off peak loads need not affect the retirement system of a company nor interfere with lines of promotion, apprenticeship jobs, and other factors vital to employment planned on a permanent basis.

From the viewpoint of the older prospective employee, the 50-plus man or the Social Security beneficiary of over 65, there are deterrents too. These would tend to dampen the desire to take a "by the day or week" position as a temporary helper but not an integral part of a going organization. Grant-

Mr. Carey is Secretary Emeritus of the American Society of Civil Engineers.

Eta Kappa Nu Jury of Award

THE ETA KAPPA NU Jury of Award which selected Dr. J. J. Baruch, vice-president and treasurer of Bolt, Beranek and Newman, Cambridge, Mass., as the Outstanding Young Electrical Engineer for 1956, and R. B. Seidel, president of Automatic Temperature Control Company, Philadelphia, Pa., for honorable mention, was made up of (*left to right*) M. D. Hooven, electrical engineer, Public Service Electric and Gas Company of Newark, N.J., past president of AIEE, chairman of the Jury of Award; K. B. McEachron, Jr., dean of engineering, Case Institute of Technology; S. R. Warren, assistant vice-president of undergraduate engineering affairs, University of Pennsylvania, past president of Eta Kappa Nu; J. E. Hobson, former director of Stanford Research Institute, past president of Eta Kappa Nu; J. W. McRae, president, Sandia Corporation; and N. S. Hibsham, secretary of AIEE, past president of Eta Kappa Nu. The meeting was held in New York, N.Y., at AIEE Headquarters, October 20, 1956.

ing the handicaps which exist from the viewpoint of both employer and prospective older employees, it still seems reasonable that some of the shortage of engineers could be met by greater use of the older members of our profession now unemployed or retired.

ESPS does not now know how many of such potential employees are available. If you are an engineer or scientist over 50, unemployed or retired, and if you are willing and able to take a temporary job, please tell ESPS. Send a brief letter to Engineering Societies Personnel Service, 8 West 40th St., New York 18, N. Y. Just tell us your professional branch, your specialty, your age, and refer to this article. If the response is adequate in numbers, the ESPS Board will attempt to work out a plan to bring these older engineers and scientists together with the industries needing them.

It should be borne in mind, of course, that ESPS with offices in New York, N. Y., Chicago, Ill., Detroit, Mich., and San Francisco, Calif., continues ready to help any engineer or scientist of any age to better his position or to obtain one. ESPS also continues to try to locate the particular engineer or scientist any specific employer may want. These have been the routine tasks of ESPS for more than 25 years. The proposal discussed here contemplates a special kind of placement from a yet unknown number of "prospects" 50 plus in years who still desire to help themselves and their profession in the work of the nation.

C. A. Adams To Receive The Edison Medal for 1956

The Edison Medal Committee of the AIEE has awarded the Edison Medal for 1956 to Dr. C. A. Adams (AM '94, M '05, F '13, Member for Life). The presentation will take place during the general session of the Winter General Meeting, Monday afternoon, January 21, 1957, at the Hotel Statler, New York, N. Y.

The citation which will accompany the medal reads as follows:

> "For pioneering achievements in the development of alternating current electric machinery and in electric welding; for vision and initiative in the formation of an engineering standards organization; and for eminence as an educator and consulting engineer."

Dr. Adams was born in Cleveland, Ohio, November 1, 1868. He attended the Case School of Applied Science (now the Case Institute of Technology) where, for his four undergraduate years, he was laboratory assistant to A. A. Michelson, renowned physicist.

C. A. Adams

His degrees from Case are B. S. in 1890, E. E. in 1905, and D. Eng. in 1925. He also received an honorary degree of D. Eng. from Lehigh University in 1938.

After graduation from Case in 1890, he spent a year with the Brush Electric Company in Cleveland, Ohio, where he participated actively in the design of the first gearless traction motor.

In 1891, he was appointed instructor in electrical engineering at Harvard University where he taught for 45 years. His present title is Abbot and James Lawrence Professor of Engineering and Gordon McKay Professor of Electrical Engineering, Emeritus, since 1936.

Dr. Adams early developed a keen interest in the theory and design of electrical machinery and wrote numerous papers in that field. Some of those relating to induction motors are still classics.

His original analysis of the wave shape af alternators is still generally utilized and appears in the "Standards Handbook for Electrical Engineers."

As a consultant, Dr. Adams' major clients were: American Tool and Machine Company, The Stone and Webster Company, The Warner Sugar Refining Company, The American Sugar Refining Company, The Boston Edison Company, The Public Service Electric and Gas Company of New Jersey, The Okonite Company, Babcock and Wilcox Boiler Company, General Electric Company, and Budd Company.

He was a member of the Jury of Awards in the Electrical Field for the International Exhibition in St. Louis, Mo., in 1904. At the same time, he presented two papers at the International Electrical Congress taking place there, and participated in the founding of the International Electrotechnical Commission of which he was a member for many years.

Dr. Adams is one of 35 engineering members of the National Academy of Sciences; a Fellow of the American Academy of Arts and Sciences, and of the American Physical Society; a member of the American Society of Civil Engineers; a Fellow of the American Society of Mechanical Engineers and for 20 years a member of its Boiler Code Committee. He is a charter member of the Electrochemical Society and an early member of the Society for the Promotion of Engineering Education. He is a member of the British Institution of Electrical Engineers and of the Societe Francaise des Electriciens.

He was organizer and first president of the American Welding Society (AWS), an honorary member, and first recipient of its Miller Medal. An annual feature of the AWS is the Adams Lecture. He is also an honorary member of the International Acetylene Association and organizer and first chairman of the Welding Research Council.

Dr. Adams is a Fellow and past president of the AIEE. For 10 years, he was chairman or secretary of its Standards Committee. He is past chairman of the Edison Medal Committee as well as of the Committee on Ethics. In 1940, he was awarded the Lamme Medal.

For 15 years, he has been a member of the Franklin Institute Committee on Science and the Arts which selects the medalists for the numerous Institute Medals.

In 1917, he started a movement for the organization of a general engineering Standards Committee to cover all fields of engineering. When this committee was organized he was the first chairman. As its work developed, its name was changed to the present American Standards Association which covers practically the whole field of industrial standards.

AIEE Nominating Committee Will Meet in New York, N. Y.

The AIEE Nominating Committee will meet in the Boston Room, Hotel Statler, New York, N. Y., 10 a.m., January 21, 1957, during the Winter General Meeting of the Institute, to nominate candidates for AIEE offices to be voted on by the membership in the spring of 1957. (See Constitution VI 30, 31, 32, 33; Bylaws 27, 28, and *Electrical Engineering* November 1956, page 1038). Representatives receive travel allowance. Alternates are required to attend only if called upon to serve in place of their representative. Members of the committee are as follows:

Representing the 11 geographical Districts:

1. E. M. Morecock, Rochester Institute of Technology, Rochester, N.Y.
2. S. R. Warren, Jr., Univ. of Pennsylvania, 300 South 33rd St., Philadelphia 4, Pa.
3. W. A. Clark, American Tel. & Tel. Co., 195 Broadway, New York 7, N.Y.
4. H. C. Sells, Allis-Chalmers Mfg. Co., 702 Hamilton Bank Bldg., Knoxville, Tenn.
5. J. R. North, Commonwealth Associates, Inc., 209 E. Washington Ave., Jackson, Mich.
6. E. B. Fowler, Northwestern Bell Tel. Co., 118 South 19th St., Omaha 2, Neb.
7. R. C. Hase, 1823 Telephone Bldg., St. Louis, Mo.
8. G. T. Harness, University of Southern California, University Park, Los Angeles 7, Calif.
9. O. W. Hurd, P.O. Box 247, Kennewick, Wash
10. G. D. Floyd, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Canada.
11. J. W. Rittenhouse, Hi-Voltage Equipment Co., 4000 East 116th St., Cleveland, Ohio.

Alternates for the District Representatives:

1. J. C. Hitts, Jackson & Moreland, Park Square Bldg., Boston 16, Mass.
2. Hendley Blackmon, Westinghouse Electric Corp., Office 7-L-38, East Pittsburgh, Pa.
3. R. W. Gillette, Consolidated Edison Co. of N.Y., Inc., 4 Irving Place, New York 3, N.Y.
4. W. P. Molette, General Electric Co., 700 East Franklin St., Richmond 17, Va.
5. W. M. Ballenger, General Electric Co., 840 South Canal St., Chicago 80, Ill.
6. P. T. Baird, Consumers Public Power District, 1401 O St., Lincoln, Neb.
7. S. M. Sharp, Southwestern Gas & Elec. Co., P.O. Box 1106, Shreveport, La.
8. P. L. Savage, General Electric Co., 212 North Vignes St., Los Angeles, Calif.
9. H. A. Carlberg, General Electric Co., Hanford Works, Richland, Wash.
10. D. G. Geiger, Bell Tel. Co. of Canada, 393 University Ave., Toronto, Ont., Canada
11. W. A. Dynes, 312 Lonsdale Ave., Dayton, Ohio

Representing the six technical Divisions:

Communication—I. S. Coggeshall, Western Union Telegraph Co., 60 Hudson St., New York 13, N.Y.
General Applications—R. L. Oetting, General Electric Co., Nela Park, Cleveland 12, Ohio
Industry—C. N. Clark, Duquesne Light Co., 435 Sixth Ave., Pittsburgh 19, Pa.
Instrumentation—C. F. Savage, General Electric Co., 570 Lexington Ave., New York 22, N.Y.

Power—C. T. Hatcher, Consolidated Edison Co., of N.Y., Inc., 4 Irving Place, New York 3, N.Y.
Science & Electronics—J. G. Reid, Jr., National Academy of Sciences, Washington, DC.

Alternates for Division Representatives:

Communication—John Messar, Bell Telephone Laboratories, Inc., 463 West St., New York, N.Y.
General Applications—T. C. Johnson, General Electric Co., 1 River Road, Schenectady 5, N.Y.
Industry—H. W. Cory, Allis-Chalmers Mfg. Co., Hawley Works, Milwaukee, Wis.
Instrumentation—P. K. McElroy, General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.
Power—E. I. Pollard, Elliott Company, Ridgway, Pa.
Science & Electronics—D. E. Trucksess, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.

Representing the Board of Directors:

B. G. Ballard, National Research Council of Can., Sussex St., Ottawa, Ont., Canada
W. R. Brownlee, Southern Services Inc., Birmingham, Ala.
Bradley Cousens, Box 3669—Terminal Annex, Los Angeles 54, Calif.
C. T. Pearce, Westinghouse Electric Corp., 3001 Walnut St., Philadelphia 4, Pa.
J. D. Tebo, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N.Y.
J. C. Woods, Commonwealth Edison Company, 72 West Adams Street, Chicago 90, Ill.

Alternates for Board Representatives:

J. H. Foote, Commonwealth Associates Inc., 209 E. Washington Ave., Jackson, Mich.
L. M. Robertson, Public Service Co. of Colo., Denver, Colo.
D. I. Cone, 1257 Martin Ave., Palo Alto, Calif.
M. D. Hooven, Public Service Elec. & Gas Co., 80 Park Place, Newark 1, N.J.

The following provisions of the Constitution and Bylaws relate to the organization and procedures of the Nominating Committee.

Constitution

C30. There shall be constituted each year a Nominating Committee consisting of one representative of each geographical District, elected by its executive committee, one representative of each technical division elected by the division committee, and other members chosen by and from the Board of Directors not exceeding in number the number of technical divisions; all to be selected when and as provided in the Bylaws. The Secretary of the Institute shall be the secretary of the Nominating Committee, without voting power.

C31. The executive committee of each geographical District shall act as a nominating committee of the candidate for election as Vice-President of that District or for filling a vacancy in such office for an unexpired term, whenever a vacancy occurs.

C32. The Nominating Committee shall receive such suggestions and proposals as any member or group of members may desire to offer, such suggestions being sent to the secretary of the committee.

The Nominating Committee shall name, on or before January 31 of each year, one or more candidates for President, Treasurer, and the proper number of Directors, and shall include in its ticket such candidates for Vice-Presidents as have been named by the nominating committees of the respective geographical Districts, if received by the Nominating Committee when and as provided in the Bylaws; otherwise the Nominating Committee shall nominate one or more candidates for Vice-President(s) from the District(s) concerned.

C33. Independent nominations may be made by a petition of twenty-five (25) or more corporate members sent to the Secretary when and as provided in the Bylaws; such petitions for the nomination of Vice-Presidents shall be signed only by members within the District concerned.

Bylaws

B27. The secretary of the Nominating Committee shall give the members not less than ten days' notice of the first meeting of the committee, which shall be held not later than February fifteenth.* At this meeting, the committee shall elect a chairman and shall proceed to make up a ticket of nominees for the offices to be filled at the next election. To insure that full consideration be given to all suggestions from the general membership, they must be in the hands of the secretary of the committee by December fifteenth. The nominations as made by the Nominating Committee shall be published in the March issue of *Electrical Engineering*, or otherwise mailed to the Institute membership not later than the first week in March.

B28. Petitions proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C33 (Constitution), must be received by the secretary of the Nominating Committee not later than March fifteenth of each year, to be placed before that committee for the inclusion in the ballot such candidates as are eligible.

B28.1. The candidates shall appear on the ballot, grouped alphabetically under the name of the office for which each is a candidate. The voting in each case shall be restricted to the nominees printed on the ballot. The ballot shall be mailed to the membership by April 15.

* Adopted subject to pending modification of C32.

New AIEE Medal Announced: Request Is Made for Nominees

A new medal has been established in the Institute for outstanding achievement in electrical engineering education. The first gold medal was awarded to Dr. F. E. Terman during the Fall General Meeting, October 2, 1956, for his many significant contributions to the teaching of electrical engineering.

In accordance with the "Bylaws of the Medals Provided from the Members-for-Life Fund," the award will be based upon teaching excellence, ability to inspire students to higher achievements, contributions to the teaching of electrical engineering in textbooks and in writings on engineering education, active participation in the work of the professional and educational societies, and contributions to teaching and the profession through research, engineering achievements, and technical papers.

The Members-for-Life Fund is derived from the dues which Members-for-Life continue to pay voluntarily after becoming exempt from further payment in accordance with Institute Bylaws. By a vote of the Board of Directors, the fund was set aside separately to be used for "special purposes rather than for the general purposes of the Institute." In order to administer the accumulated payments, a Members-for-Life Fund Committee was established. Each year it makes recommendations to the Board of Directors for its approval on the use of this money.

So far, the fund has been used solely for defraying expenses to the Summer General Meeting of several district winners of student paper competitions. However, the fund has gradually increased so that it has become possible to sponsor an additional useful project. In considering several proposals, the committee's attention was called to the fact that the Institute is noticeably lacking in medals and awards by which outstanding achievements of members could be recognized—particularly in special fields. Moreover, the Board already has endorsed in principle a recommendation that the available funds can be used for prizes. Therefore, it seemed to the committee that further use of the fund to establish one or more medals was not only a worthy project, but also one meeting aproval of contributors.

In considering the several fields in which the award might be made, it was thought that the first medal should be awarded in the field of electrical engineering education. This is an important field and one in which the Institute has no specific means of recognizing any outstanding achievements.

Administration of the award of succeeding medals has been given to the AIEE Prize Awards Committee. The Committee invites members to submit names of nominees. Such nominations may be made by procuring a nomination form from E. C. Day, Secretary, Prize Awards Committee, 33

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until January 30. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y., on or before January 30.

56-159 An Equitable Method for the Distribution of Power Pool Savings. *H. W. Phillips*

56-707 Flexible Copper Braid for Electric Busses and Connectors. *Morris Brenner*

56-996 Excitation System Response—A Utility Viewpoint. *P. L. Dandeno, K. R. McClymont*

56-1010 Calculation of Windage Noise Power Level in Large Induction Motors. *M. E. Talaat*

56-1013 Synchronizing Out of Phase. *A. J. Wood*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th St., New York 18, N. Y.

W. 39th St., New York 18, N. Y. The form should be accompanied by at least two supporting letters from others who are familiar with the accomplishments and the qualifications of the nominee. It is desirable that at least one letter come from a former student of the nominee. The forms and letters are due at headquarters not later than May 1, 1957. All nominations received last year in connection with the award of this medal will be considered by the Committee this year without further nomination. Supplementary information on these past nominees may, of course, be forwarded for attachment to the present file on these outstanding educators in electrical engineering education.

1957 Nuclear Congress Names General Arrangements Committee

A committee representing major United States engineering and scientific societies has been named to handle arrangements for the 1957 Nuclear Congress and International Atomic Exposition, Philadelphia, Pa.

The National Industrial Conference Board and 20 top technical groups, including the Engineers Joint Council (EJC), are co-operating in the congress, to take place in Philadelphia's Convention Hall, March 11-15, 1957.

The committee is now making plans to accommodate an overflow attendance far in excess of the 1955 Congress in Cleveland, Ohio. Among the major events are 40 separate sessions of technical groups, conducted by the EJC; a two-day "Atomic Energy for Industry" management conference organized by the National Industrial Conference Board; as well as a two-day "Hot Laboratories and Equipment" conference.

Exhibits at the five day Atomic Exposition, the committee reports, will be bigger and more diversified than ever before. Many new firms are exhibiting for the first time. Space reservations are coming in at a record rate to Exposition Headquarters at 117 South 17th St., Philadelphia 3, Pa.

Members of the General Arrangements Committee and the technical societies to which they belong are: G. E. Beggs, AIEE, Institute of Radio Engineers (IRE), Leeds & Northrup Company, Technical Events Committee, AIEE representative; W. E. Belcher, Jr., American Society of Mechanical Engineers (ASME), Minneapolis-Honeywell Regulator Co., Brown Instrument Division, vice-chairman, ASME representative; R. W. Buntin, ASME, Babcox & Wilcox, chairman, Hotel Committee; J. S. Burlew, American Chemical Society (ACS), The Franklin Institute, chairman, Printing and Signs Committee; H. M. Chance II, Association of Iron and Steel Engineers (AISE), American Society of Civil Engineers (ASCE), United Engineers & Constructors, chairman, Finance Committee; C. S. Doerr, ASME, Society of Automotive Engineers (SAE), The Engineers Club of Philadelphia, Engineers Club representative; J. H. Ferguson, ASCE, Society of American Military Engineers (SAME), Federal Housing, Transportation Committee, ACSE representative; J. V. Friel, director, International Atomic Exposition; L. R. Gaty, AIEE, ASME, Pennsylvania Society of Professional Engineers (PSPE), Philadelphia Electric Company, chairman, General Arrangements Committee; H. F. Grebe, exhibits manager, International Atomic Exposition; Howard Gross, American Society of Tool Engineers (ASTE), Spring Garden Institute, dean—retired; W. F. Henn, AIEE, General Electric Company, Information Committee; T. W. Hopper, ASME, PSPE, Day & Zimmermann, Inc., chairman, Registration Committee; T. A. Marshall, Jr., ASME, assistant secretary; C. C. Peavy, American Institute of Chemical Engineers (AIChE), Houdry Process Company, Reception Committee, AIChE representative; Mrs. D. M. Shackleford, assistant manager, Nuclear Engineering and Science Congress; R. L. Smith, American Society for Metals (ASM), American Institute of Mining, Metallurgical and Petroleum Engineers (AIME), The Franklin Institute, AIME representative; T. E. Stieber, AIEE, Westinghouse Electric Corporation, chairman, Entertainment Committee; R. R. Wagstaff, PSPE, AIEE, AISE, United Engineers & Constructors, vice-chairman, Information Committee; S. R. Warren, Jr., AIEE, vice-president, University of Pennsylvania, chairman, Ladies Committee; B. W. Webb, ASME, Combustion Engineering, Inc., chairman, Publicity Committee.

Courtesy Jules Schick

MEMBERS of the General Arrangements Committee for the 1957 Nuclear Congress and International Atomic Exposition are *(seated, left to right)* **R. R. Wagstaff, J. S. Burlew, R. L. Smith, C. S. Doerr, W. E. Belcher, Jr., Mrs. D. M. Shackleford, L. R. Gaty, Howard Gross, C. C. Peavy, G. E. Beggs, T. E. Stieber, R. W. Buntin,** *(standing, left to right)* **S. R. Warren, Jr., H. F. Grebe, B. W. Webb, H. M. Chance II, J. H. Ferguson, J. V. Friel, T. A. Marshall, Jr., and T. W. Hopper.**

Fortescue Fellowship Applicants Must File by February 15, 1957

Funds have been made available for one or more Charles LeGeyt Fortescue Fellowships for 1957-58. The awards are made to postgraduate students in the field of electrical engineering who have received their baccalaureate degree from a duly recognized technical school in the United States or Canada. The amount of the award is to be determined by the committee in charge.

Candidates for the Charles LeGeyt Fortescue Fellowships should file applications on the form provided by AIEE so that they reach the Chairman of the Fellowship Committee by February 15, 1957. Awards will be made not later than April 2. Copies of the application forms are available at accredited colleges or at AIEE Headquarters, 33 West 39th St., New York 18, N. Y.

The Charles LeGeyt Fortescue Fellowship, sponsored by AIEE, was established in 1939 as a memorial to Charles Fortescue in recognition of his valuable contribution to the electric power industry. To this end, the Westinghouse Electric Corporation, with which Doctor Fortescue was associated throughout his professional career, set up a trust fund of $25,000 to provide graduate fellowships in electrical engineering.

The successful candidates are selected by the AIEE committee which administers the fund. In 1956-57, two Scholarships of $2,000 each were awarded.

It is intended that candidates shall pursue their studies at accredited engineering schools and engage in research problems meeting the approval of the Fellowship Committee. To be eligible, the student must have received a bachelor's degree from an accredited college by the time his work under the fellowship would begin, provided he does not hold or subsequently receive any other fellowship which carries a stipend greater than the tuition required by the institution at which the graduate work is to be undertaken.

New York Section Appoints W. G. Vieth 1956-57 Treasurer

W. G. Vieth, of Harrington Park, N. J., has been elected 1956-57 treasurer of the AIEE New York Section, according to an announcement by W. A. Clark, chairman of the Section. With more than 6,000 members in New York, northern New Jersey, and Long Island, the Section is the largest of 110 similar units throughout the United States and Canada.

Mr. Vieth is project engineer, development and research department, Western Union Telegraph Company, New York,

N. Y., with which he has been associated since 1927. He holds a degree in electrical engineering from New York University.

Mr. Vieth has been active in Section and Institute affairs for many years. He has been a member of the Institute's Winter General Meeting Committee for eight years and presently is a member of the Smoker Committee for the 1957 Meeting. He is a past chairman of the Section's Communications Division, and was program co-ordinator for the Section last year. He also is a trustee of the Engineering Societies Library Board and of the Engineering Index.

Richland Section Holds Dinner Meeting

The new officers of the Richland Section took over the reins at a dinner meeting, October 23, 1956, held at the Desert Inn, Richland, Wash.

E. J. Barrett, retiring chairman, was presented with a certificate by Roy Hoffman, incoming chairman, in appreciation for Mr. Barrett's services as chairman of the Richland Section during the past year.

A feature of the meeting was the presentation to W. J. Dowis by M. M. Ewell, District 9 vice-president, of a diploma certifying Mr. Dowis' transfer to the grade of Fellow in the AIEE.

H. A. Carlberg, vice-chairman of the Section, and C. R. Bergdahl, Technical Committee chairman, outlined the new program for the Richland Section for the coming year. An important part of the program will be the organization of technical discussion and papers groups in several of the major fields of interest of the members. It is anticipated that the establishment of these technical groups will stimulate and generally strengthen individual member participation in the Section program.

Meeting Held by District 9 Executive Committee

The regular meeting of the District 9 Executive Committee was held in the Board Room of Portland General Electric Company in Portland, Ore., on September 14, 1956.

Vice-President M. M. Ewell presided at the meeting which was opened by a general discussion of the manifold activities of the Institute at the national level, including a discussion of a proposed location of a new engineering center, the current thinking relative to unity, the recent changes in the organization structure of the Institute, and the problems of promoting greater technical activity at the section level.

The practice of contributing an additional $100 for student activities will be continued. This money will be procured from the sections on a pro rata basis. The student paper contest for the current year will be held at Montana State College in Bozeman, Mont.

Considerable time was given to a discussion of section status, following which the Executive Committee endorsed the petition of the Vancouver Island Subsection which will, when authorized, be known as the Victoria Section. Along the same line, the Executive Committee approved the formation of an Idaho Section to be comprised of the present Boise and Eastern Idaho Subsections, provided that complete agreement is reached between all interested parties.

E. J. BARRETT *(right)*, retiring chairman of the Richland Section, receives a certificate expressing appreciation for his services from Roy Hoffman *(left)*, incoming chairman, at a recent Dinner Meeting of the Section.

Courtesy R. A. Clemenson

Salt Lake City, Utah, was selected as the location for the 1961 Pacific General Meeting, and Spokane, Wash., was recommended for the 1963 Pacific General Meeting.

Gray Clifton, chairman of the 1957 Pacific General Meeting which will be held in Richland, Wash., reported at some length on the status of arrangements. In this connection, it was recommended that the Board of Directors be invited to hold a meeting at Richland. The Richland Section was also authorized to select the district representative on the Nominating Committee, which will meet at the Winter General Meeting to nominate national officers.

A second District Executive Committee Meeting will be held on Friday, February 15, 1957, in Spokane, Wash.

Those in attendance were: M. M. Ewell, vice-president; Howard Arnett, secretary; R. E. Kistler, director; W. J. Wheeler, chairman, Montana Section; H. L. Baker, secretary-treasurer, Montana Section; C. R. Beitman, chairman, Billings Subsection; C. B. Brown, alternate for past vice-president; A. E. Opdenweyer, chairman, Portland Section; J. G. Kirwan, vice-chairman, Portland Section; E. B. Hedberg, chairman, Medford Subsection; P. C. Magnusson, chairman, Eugene Subsection; R. C. Hoffman, chairman, Richland Section; H. A. Carlberg, vice-chairman, Richland Section; C. R. Kingsbury, chairman, Seattle Section; E. M. Lee, secretary-treasurer, Seattle Section; C. H. Staff, chairman, Tacoma Subsection; J. D. Fox, chairman, Spokane Section; S. G. Yates, delegate, Spokane Section;

Space Flight Discussion

Photo by F. J. Lovelock

DR. H. R. FRIEDRICH *(left)*, chief flight mechanics engineer, Convair-Astronautics, San Diego, Calif., explains the possibilities of traveling to Mars or Venus within 15 years to W. B. Freeman *(right)*, member of the Program Committee of the San Francisco Section of AIEE. Dr. Friedrich discussed the mechanics of space flight before a joint meeting of AIEE and the American Rocket Society on November 13 at the University of California, Berkeley.

OFFICERS of the Marion Subsection of the AIEE, Donald Ruff *(second from left)*, secretary-treasurer, and Robert Stanley *(right)*, chairman, discuss the organization of the newly formed subsection with J. H. Capps *(left)*, chairman of the parent Fort Wayne Section, and J. H. Foote *(second from right)*, vice-president of District 5.

J. A. Davis, chairman, Utah Section; E. W. Hendron, secretary-treasurer, Utah Section; P. W. Worthen, chairman, Boise Subsection; M. M. Dye, chairman, Eastern Idaho Subsection; R. B. Carter, Chairman, Vancouver Section; G. J. Henrikson, vice-chairman, Vancouver Section; A. F. Thommasen, chairman, Vancouver Island Subsection; R. M. Gilbert, vice-chairman, AIEE Membership Committee; R. E. Durnford, chairman, District 9 Committee on Student Activities; E. C. Starr, representative, Technical Operations Department; Gray Clifton, chairman, 1957 Pacific General Meeting, Richland Section; and H. R. Hughes, Richland Section.

James H. McGraw Award Presented at NEMA Meeting

A. A. Berard, president, Ward Leonard Electric Company, Mt. Vernon, N. Y., and V. R. Tate (M '38), executive vice-president, Perfex Corporation, Milwaukee, Wis., received the James H. McGraw Award, Electrical Manufacturers Medal and Purse at the annual meeting of the National Electrical Manufacturers Association (NEMA) in Atlantic City, N. J., on November 14, 1956.

AIEE Subsection Formed at Marion, Ind.

An organizational meeting was held Wednesday evening October 10, 1956, to form the Marion Subsection of the Fort Wayne Section, District 5, of the AIEE. The newly formed Subsection was allocated Grant, Blackford, Jay, Miami, and Wabash counties of Indiana by the parent Fort Wayne Section.

J. H. Capps, chairman of the Fort Wayne Section, presided at the meeting at which Robert Stanley and Donald Ruff presented the formal petition requesting the formation of the Subsection. Mr. Stanley and Mr. Ruff were later appointed chairman and secretary-treasurer, respectively, of the Subsection.

J. H. Foote, vice-president of District 5, gave an inspiring talk entitled "Let's Be Professional Engineers." Mr. Foote was introduced by C. M. Summers, past vice-president of District 5, and member of the Fort Wayne Section.

Paper and Pulp Industry Subcommittee Officers Elected

G. I. Burner, chief electrical engineer of The Rust Engineering Company, Pittsburgh, Pa., has been elected chairman of the AIEE Subcommitee on Paper and Pulp Industry.

Results of the election held by the Executive Committee of AIEE were announced by S. A. Bobe, retiring Subcommittee chairman. Mr. Bobe is with Westinghouse Electric Corporation, Atlanta, Ga.

Other Subcommittee officers for the 1956-57 term include C. H. Hudson, General Electric Company, Atlanta, Ga., vice-chairman; and E. K. Murphy, Rayonier, Inc., New York, N. Y., secretary.

The Subcommittee presently is completing plans for AIEE's Annual Paper Industry Conference to be held March 28-29, 1957, at Georgia Institute of Technology, Atlanta, Ga. This conference will be conducted in co-operation with the Institute and the local AIEE subsection.

Mr. Burner holds a B.S. degree in E.E. from West Virginia University, and is a registered professional engineer in the Commonwealth of Pennsylvania. He is a member of the Electrical Engineering Committee of the Technical Association of the Pulp and Paper Industry.

Engineering Foundation Receives More Research Funds

Engineering Foundation will be able to take on more research projects with the income from a bequest for the benefit of the Foundation to United Engineering Trustees, Inc., custodian of the Foundation's funds. The bequest of some $425,000 is currently

Fellow Diploma Presented

Courtesy Anson

DISTRICT 2 VICE-PRESIDENT C. T. Pearce *(left)* presented the Fellow diploma to Walter Schaelchlin *(center)* at a meeting of the Washington Section on October 9, 1956, as D. S. Bender *(right)*, chairman of the Washington Section, observed the presentation. Mr. Schaelchlin is consulting engineer to the Control Division of the Westinghouse Electric Corporation, Buffalo, N. Y. The presentation was made at the first fall meeting of the Washington Section at which Mr. Pearce was the principal speaker.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

being made available to United Engineering Trustees, Inc., from the estate of the late E. H. McHenry, civil engineer and railroad executive, of Ardmore, Pa., who died August 21, 1931.

In his will, Mr. McHenry provided that upon the death of the last beneficiary his entire estate should go to United Engineering Trustees, Inc., which is empowered to pay the net income from it to Engineering Foundation for a period of 30 years. The will expressly stipulates that Mr. McHenry's gift ". . . constitute and be kept as a special trust fund for the furtherance of research in science and engineering . . ." and that it be dedicated to the memory of his wife, Blanche H. McHenry. At the expiration of the 30-year period, the principal of the fund held by United Engineering Trustees, Inc., may also be applied to Engineering Foundation research projects.

A native of Cincinnati, Ohio, Mr. McHenry was chief engineer for the Northern Pacific and Canadian Pacific railways at various stages of his career, and a vice-president in charge of engineering of the New York, New Haven and Hartford Railroad. The electrification of the New Haven road, carried out under his direction, was the first large-scale undertaking of its kind in the United States. He was a member of the American Society of Civil Engineers and the Engineering Institute of Canada.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Communications Division

Committee on Wire Communications Systems (L. E. Montfort, *Chairman*, D. T. Osgood, *Vice-Chairman*, J. R. Hyneman, *Secretary*). Programs for the forthcoming Winter General Meeting at New York, N. Y., and the Summer Meeting at Montreal, Que., Canada, reflect the efforts of this Committee to cover the many segments of wire communications, both technically and territorially. At the Winter Meeting, one session will be devoted to the new transatlantic telephone cables and will include international participation by means of a hook-up over the new cables. The Montreal meeting, understandably, will treat communication progress in Canada and it is anticipated that progress in Europe and the operation of Comite Consultatif International Telephonique (CCIT) in maintaining standardization of transmission factors will receive attention.

The maintenance of communications equipment is a subject which is being viewed more and more seriously by communications administrators. Recognizing this, the Communications Division is considering a technical conference sponsored by AIEE with participation by organizations of users of wire and radio communications which will provide a general airing of this subject. To test sentiment, a questionnaire was distributed at one session of this division at the recent Chicago, Ill., meeting. The responses indicate wide interest, particularly in new maintenance techniques and in test methods and equipment. Maintenance personnel and their training also ranks high as a subject of interest.

General Applications Division

Committee on Air Transportation (L. R. Larson, *Chairman;* Peter Duyan, Jr., *Vice-Chairman;* D. H. Scott, *Secretary*). In recognition of the expanding needs of the aviation industry, the Committee on Air Transportation has modified its organization in two areas. These changes were made to emphasize properly the needs for design guides for missile systems and equipment installation and utilization.

The rapid expansion of the missile industry has emphasized the need of recognition of the specific needs in this area. Each of the Subcommittees has reviewed the problem to be certain that the various areas are properly covered. The Systems Subcommittee has organized a Missile System Working Group to cope with this problem. A program is being developed by this group to produce guide reports and standards to define some of the techniques applicable to missile design problems.

Miniaturization of equipment and the growth of the numbers of equipment being used has placed increased emphasis on effective heat dissipation within and from the equipment. In recognition of this problem, the Subcommittee on Rating of Airborne Electric Apparatus is forming a working group to cover this critical specialized need through the preparation of guide reports and standards.

Industry Division

Industrial Power Systems Committee (R. H. Whaley, *Chairman;* R. T. Woodruff, *Vice-Chairman;* H. H. Angel, *Secretary*). The Committee on Industrial Power Systems has, after three years, succeeded in publishing material within the scope of the Committee as recommended guides to engineers. Both the Red Book, "Electric Power Distribution for Industrial Plants," and the Green Book, "Grounding of Industrial Power Systems," are available from AIEE Headquarters.

The Red Book, a second edition, consists of 172 pages of information for electrical engineers. The purpose of this publication is to bring to the attention of engineers, owners, and plant management, the important features of well-designed electric distribution systems that result in satisfactory performance of utilization equipment and efficient operation of the plant.

Inasmuch as this is not an AIEE standard and the recommendations are not mandatory or restrictive, it is hoped that the publication will stimulate better planning of electrical systems for industrial plants.

A standing committee has been established for the continual review of the Red Book and it will be revised accordingly with the changes and developments in industry.

The Green Book, which is a report of the Subcommittee on Industrial Grounding, is published as a recommended guide to engineers. It is, in effect, an extension of Chapter 5 of the Red Book but is issued as a separate publication because it deals exclusively with the problems of grounding which is commonly faced by engineers.

The Gray Book, which is the work of the Subcommittee on Distribution Systems for Commercial Buildings, is advanced through the efforts of the 70 members who have teamed up under the chairmanship of this Subcommittee. These specialists will produce a text, "Electrical Systems for Commercial Buildings," which will be similar to the Red and Green books.

The Industrial Power Systems Committee is active in developing a standard guide for nomenclature on the various types of industrial electrical distribution systems. This Committee has recently reactivated the Subcommittee on Characteristics of Loads and is continuing its activities of the Subcommittee on Codes and Standards and the Pacific Coast Subcommittee.

Technical sessions are being planned for the general meetings between now and including the Summer General Meeting of 195?

Instrumentation Division

Committee on Flight Test Instrumentation (W. S. Pritchett, *Chairman;* V. R. Boulton, *Vice-Chairman;* W. C. Brown, *Acting Secretary*). A new statement of scope was submitted by this Committee for Division approval at its New York, N. Y., meeting of November 9, 1956. This was done because the present scope, carried over from Group Subcommittee VIII of the former Committee on Instruments and Measurements, is not adequate. The new scope covers instrumentation of all bodies in flight. Plans are

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus* and Systems, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

under way for technical sessions at the Pacific General Meeting in Pasco, Wash., August 28-30, 1957.

Power Division

Committee on Power Generation (F. L. Lawton, *Chairman;* J. H. Kinghorn, *Vice-Chairman;* C. F. Paulus, *Secretary*). The Integrated Control Working Group is currently studying the question of minimum protection for boilers, turbines, generators, and auxiliaries, initially with emphasis on the electrical end. Co-operation with the varied interests is being developed for joint activity. This work is rapidly assuming greater importance than originally anticipated because of substantial progress in the field of supercritical pressures.

The Joint AIEE-American Society of Mechanical Engineers (ASME) Committee on Recommended Specifications for Prime Mover Speed Governing Subcommittee has completed its "Tentative Recommended Specifications for the Speed-Governing of Internal Combustion Engine-Generator Units." It is anticipated that this will eventually be made available for trial use similar to AIEE Nos. 600 and 605, Recommended Specifications for Speed-Governing of Steam Turbines and Hydraulic Turbines, respectively. Plans are being developed for a conference session dealing with speed-governing at the 1957 Fall Meeting.

The Excitation Systems Subcommittee has made substantial progress in the area of relevant definitions and it is anticipated considerable clarification of the confusion which has existed in this field will result.

A Working Group of the Hydroelectric Systems Subcommittee investigating industry experience with thrust bearings for large hydroelectric units is expected to report the findings from its questionnaire shortly.

Science and Electronics Division

Nucleonics Committee (P. N. Ross, *Chairman;* T. S. Gray, *Vice-Chairman;* G. A. Morton, *Secretary*). The Nucleonics Committee has devoted much effort to aiding Engineers Joint Council (EJC) in planning the technical program for the Second EJC Nuclear Science and Engineering Congress to be held in Philadelphia, Pa. on March 11-16, 1957. It was desired to have substantial AIEE participation in the congress and with the assistance of the Nucleonics and Radiation Instruments Committee (E. E. Lynch, *Chairman*) this has been achieved. There will be a total of approximately 20 papers presented at the congress under AIEE sponsorship in four sessions covering Reactor Plant Operation and Maintenance, Reactor Plant Instrumentation, Reactor Control and Simulators, and Reactor Instrument Development.

In addition to the congress paper program, the Nucleonics Committee is sponsoring a single session at the Winter General Meeting on the subject of Nuclear Machines with J. G. Hutton as chairman.

Dielectric Devices Subcommittee (H. Epstein, *Chairman*—AIEE; C. A. Rosen, *Chairman*—IRE) of the Solid State Devices Committee. The Dielectric Subcommittee has begun essentially full-scale activity this year. Its present membership numbers 26. The three main areas of cognizance, indicating present and future uses of devices, include ferroelectric devices, electrophotic devices, and devices based upon the formation and utilization of electric charged surface phenomena. Consistent with the committee's scope of activities, three task groups one in each of the respective areas, have undertaken the task of defining terms for devices and usage in the field.

The Subcommittee is sponsoring a session at the Winter General Meeting, January 1957. An attempt is being made to program the session in a somewhat novel approach. The Subcommittee is presenting a tutorial session on the status of Solid-State Dielectric Devices, presented as a coherent unified series of short talks presented by the most competent people in the specific areas. There is much less association of author and paper in this session than is normally the case, because the aim is to present a committee report rather than a series of talks on new products and the like. The tutorial session will give an up-to-date status in the field and indications of future developments.

The general plan of the Subcommittee's activity is to provide definitions in the new areas within the subcommittee's cognizance. These definitions involve definitions of terms and devices as they are developed in the industry. It is also the aim of the Subcommittee to sponsor technical sessions, both tutorial in nature and also up-to-date reports on the activities in the industry. It is the aim that all papers reporting progress contain only new material which has not been presented previously and that a very high standard be maintained on the quality of any papers which are presented.

The Subcommittee has found it extremely desirable to hold luncheon committee meetings. The luncheon meeting allows the subcommittee members to get to know each other much better and discuss the technical matters at a much closer level than is possible otherwise. Generally, these luncheon meetings coincide with national meetings sponsored by the parent organizations.

The Subcommittee is also involved in the planning of a Symposium on Ferroelectric Devices to be held in Washington in the Spring of 1957. This symposium plans to cover the latest developments in the ferroelectric devices area, and is one of a series in which the committee will partake.

AIEE FELLOWS ELECTED

Board of Directors Meeting, October 5, 1956

Edward Roche Coulbourn (M '39), engineering manager, Alabama Power Company, Birmingham, Ala., has been transferred to the grade of Fellow in the AIEE ". . . for his achievements in the design of an extensive electric production, transmission, and distribution system." Mr. Coulbourn was born in Birmingham, Ala., May 27, 1902. He recived a B. S. degree in M. E. from the Universiay of Alabama in 1923. From 1924 to 1925, he was with the Alabama Power Company as an engineer, Office of Distribution. During the years 1925 to 1932, he was employed first by the Dixie Construction Company and then by Allied Engineers as a distribution engineer. He assumed that same position with the Alabama Power Company in 1932. He was made senior engineer—transmission and distribution in 1937, chief electrical engineer in 1946, and engineering manager in 1951. In his present position he is responsible for the direction of generation, transmission, and distribution studies required for a large and rapidly growing power company, including administration of electrical, mechanical, structural, and architectural engineering. The scope of activities includes planning and design of system additions, economic comparisons of alternative plans, general technical engineering, methods, and standards. Mr. Coulbourn served as chairman of the Alabama Section. 1943-44 and as vice-chairman of the Membership Committee of District 4, 1951-53. He has served on the following Institute Committees Transmission and Distribution (1948-57) and Membership (1951-55).

Burns Newman Gafford (M '44), professor and chairman, department of electrical engineering, University of Texas, Austin, Tex., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions as a teacher and administrator in a University and for his promotion of a better understanding of utility power problems." Professor Gafford was born in Rogers, Tex., December 9, 1900. He attended the University of Texas, receiving a B. S. degree in E. E. in 1923 and an M. S. degree in E. E. in 1928. He began his teaching career at the University of Texas in 1923 as an instructor in electrical engineering. He was made assistant professor in 1928, associate professor in 1939, and professor in 1944. He was appointed chairman of the department of electrical engineering in 1945. In this position, which he holds at the present time, he manages budget and staff assignments, co-ordinates activities of the department, prepares reports and estimates of future growth and requirements, and works with the Budget Council—of which he became a member in 1944—on recommendations of staff appointments. He also teaches senior and graduate courses. During his career, Professor Gafford has engaged in consulting activities as well as teaching. He has worked with the City of Austin, Tex.; the City of Robstown, Tex.; Electrical Service Co.; Houston Lighting & Power Co.; and Westinghouse Electric Corporation. In 1948, he organized the annual Electric Power Distribution Conference sponsored by the department of electrical engineering and has served as chairman of the planning committee since that time. Professor Gafford is a registered profesional engineer in the State of Texas. He is a member of the American Society for Engineering Education, Tau Beta Pi, and Eta Kappa Nu.

Courtesy J. F. Kuss

E. R. Coulbourn

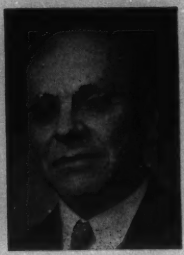
Courtesy Walter Barnes Studio

B. N. Gafford

J. R. Macintyre

Courtesy Adams Studio

C. J. Miller, Jr.



Courtesy White Studio

A. H. Mittag

John Richard Macintyre (AM '41, M '46), manager, advance engineering, Measurements Laboratory, General Electric Company, Lynn, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions in the field of instrumentation and control." Mr. Macintyre was born in England, June 29, 1908. He received a B. S. degree in E. E. from the University of Michigan in 1934. In 1936, he began his career with the General Electric Company as an engineer, instrument engineering, meter and instrument department. During his many years with the company, he has held the following positions in the meter and instrument department: design engineer, aircraft instrument engineering; engineer, general engineering; engineer, mechanical development section; engineer, mechanical development, Meter and Instrument Laboratory; supervisor, electromechanical development, Meter and Instrument Laboratory; and senior engineer, electromechanical development. In 1955, he assumed his present position as manager, advance engineering, Measurements Laboratory, where he is responsible for the operation of the advance engineering unit which develops new instruments and measuring systems. He also provides consultant services where necessary. Mr. Macintyre holds six U. S. patents and is the author of several technical papers. He is a member of the National Society of Professional Engineers and the American Ordnance Association. He has been very active in the Lynn Section of the AIEE, serving as chairman, 1953-54. He served as chairman of the Trip Committee for the AIEE Summer General Meeting in Swampscott, Mass., 1949, and secretary of the Summer Meeting in Swampscott, 1955. Mr. Macintyre served on the AIEE Feedback Control Systems Committee (1949-57).

Charles Judson Miller, Jr. (AM '32, M '41), research engineer, The Ohio Brass Company, Barberton, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to the knowledge of factors influencing high-voltage phenomena." Mr. Miller was born in Cedar Rapids, Iowa, February 8, 1908. He attended the University of California where he received the following degrees: B. S., 1931; M. S., 1932; E. E., 1933; and Ph. D., 1935. Mr. Miller joined The Ohio Brass Company in 1935 as an electrical engineer, becoming development engineer in 1940. From 1941 to 1946, he served with the U. S. Army Signal Corps. This period of military service was associated with the technical phases of the military quartz crystal program. The first year was spent in the Office of the Chief Signal Officer in Washington, D. C., and the remaining time in service was spent at the Signal Corps Signal Laboratories at Fort Monmouth, N. J. In 1946, Mr. Miller returned to The Ohio Brass Company as consulting engineer and research engineer. In the former position, he has assisted the engineering staff on the design of electrical circuits and automatic controls for production and factory testing equipment. As research engineer, he has been in charge of research relative to the flashover problems of transmission line insulation, and in extensive investigations into the radio and television interference problems associated with high-voltage transmission lines. Mr. Miller is the author of several technical articles appearing in AIEE *Transactions* and *Electrical World*. He is a registered professional engineer in the State of Ohio.

Albert Herman Mittag (AM '14, M '40) consulting engineer, General Electric Company and Fidelity Electric Company, has been transferred to grade of Fellow in AIEE ". . . for his contributions in the field of power rectification." Mr. Mittag was born in Hankinson, N. Dak., July 25, 1886. He received an E. E. degree in 1911 from the University of Minnesota. In that same year he began his professional career in the General Electric testing department. After two years, he transferred to the Student Engineers Extension Course in the consulting engineering department. From 1914 to 1922, in the office of Dr. E. F. W. Alexanderson, he was engaged in development engineering work on electric propulsion of ships. In 1922, he began work on power applications of vacuum tubes which led to the development of circuits for the uses of a newly developed gas-filled device called a thyratron. He demonstrated its use as a means for controlling the speed of a d-c motor by controlling the voltage impressed on the armature. This led to the development of thymotrol, which is in wide use today. In 1928, he was put in charge of designing and developing a single-phase commutator motor for the proposed a-c electrification of the Pennsylvania Railroad. In 1939, he became responsible for developing and designing magnetic firing circuits for ignitron rectifiers which were needed for the aluminum expansion during World War II. Within a few months, he had produced a new method of excitation which was first installed on aluminum reduction line in 1942. From 1942 to 1949, he continued to supervise the development and design of ignitron firing equipment. In 1949, he was placed in charge of development of adjustable-speed motor drives and initial work on amplistat regulators. In 1953, he retired after 42 years of active service with the General Electric Company and since then has been engaged in consulting engineering for General Electric and the Fidelity Electric Company. Mr. Mittag received two Coffin Awards from the General Electric Company—the first in 1934 for his work on thyratron gun-fire control and the second in 1946 for developing and designing the magnetic firing circuit for ignitron rectifiers. He holds 55 U. S. patents and has been the author of several technical articles. Mr. Mittag is a member of Tau Beta Pi.

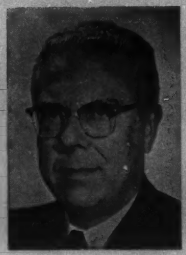
Kenneth Alva Norton (AM '41, M '48), chief, Radio Propagation Engineering Division, National Bureau of Standards, Boulder, Colo., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions in the field of radio wave propagation." Mr. Norton was born in Rockwell City, Iowa, February 27, 1907. He received a B. S. degree in physics from the University of Chicago in 1928. He spent a short time with the Western Electric Company, after which, in June 1929, he joined the Radio Section of the National Bureau of Standards. From 1934 to 1942, he was with the Federal Communications Commission as radio engineer. From 1942 to 1943, he served as assistant director in charge of the Propagation Unit for the Office of the Chief Signal Officer, Propagation Unit of the Operational Research Branch, War Department. Following this, he was an operational analyst in the Army Air Forces, first in the Operational Research Section of the Eighth Air Force, European Theater of Operations, and then in the Operational Analysis Branch of the War Department. From 1945 to 1946, he served in the Office of the Chief Signal Officer, Radio Propagation Section, War Department. He joined the National Bureau of Standards in 1946 as a physicist in the Central Radio Propagation Laboratory, where, initially, he was chief of the Frequency Utilization Research Section. Then he was made chief of the Radio Propagation Engineering Division. At Boulder Laboratories, Mr. Norton's primary responsibilities are tropospheric propagation research and studies of frequency utilization throughout the radio spectrum. Mr. Norton is a Fellow of the

Courtesy Harris & Ewing

K. A. Norton

Courtesy J. F. Knox

E. W. Robinson



Courtesy Ken Ratsch

R. J. Rockwell

Courtesy Augusta Berns

W. K. Sonnemann

E. W. Tipton

Institute of Radio Engineers, American Physical Society, and American Association for the Advancement of Science. He is a member of the American Mathematical Society, Institute of Mathematical Statistics, American Statistical Association, American Geophysical Union, and Science Research Society of America. He is the author of numerous technical reports and published papers. Mr. Norton served on the AIEE Television and Aural Broadcasting Systems Committee (1955-57).

Ronald James Rockwell (M '45), vice-president and director of engineering, Crosley Broadcasting Corporation, Cincinnati, Ohio, has been transferred to the grade of Fellow in the AIEE ". . . for his contributions in the field of high power radio broadcasting." Mr. Rockwell was born in Omaha, Neb., February 5, 1904. He attended Iowa State College, where he received a B. S. degree in E. E. in 1927 and an E. E. degree in 1946. Following graduation, he joined the test department of the engineering staff of the General Electric Company, Schenectady, N. Y., and a few months later was placed in charge of the Condenser Microphone Laboratory. In 1928, he entered engineering consultation work for broadcast stations. His first project was the design and installation of Station KTHS, Hot Springs, Ark., after which he was responsible for the design and installation of Station KLRA, Little Rock, Ark. In 1930, he went to Cincinnati, Ohio, as engineer in charge of audio circuit and speaker development for the Crosley Corporation. He was transferred to the Broadcast Division of the organization and made director of engineering in 1936. When the Broadcasting Division was separately incorporated as the Crosley Broadcasting Corporation, he was made vice-president and director of engineering, the position he holds at the present time. Mr. Rockwell holds numerous U. S. patents. He was chosen to receive the Annual Award of the Technical and Scientific Societies Council of Cincinnati for 1955-56. He is a member of the Society of Motion Picture and Television Engineers, Ohio Society of Professional Engineers, National Society of Professional Engineers, Acoustical Society of America, American Institute of Physics, American Association for the Advancement of Science, and Engineering Society of Cincinnati. He is a Fellow of the Institute of Radio Engineers.

Edgar William Robinson (M '46), consultant, Alabama Power Company, Birmingham, Ala., has been transferred to the grade of Fellow in the AIEE ". . . for his engineering and administrative achievements in the design and operation of a large steam and hydroelectric power utility." Mr. Robinson was born in Columbus, Ohio, December 1, 1889. He received an M. E. degree in E. E. in 1911 from Ohio State University. After graduation, he went to the Westinghouse Electric and Manufacturing Company as an apprentice engineer. From 1913 to 1919, he was employed by E. W. Clark & Company Management Corporation as an electrical engineer and assistant chief engineer. He was associated with R. A. Dye in electric supply business in Chattanooga, Tenn., for one year and then returned to E. W. Clark & Company Management Corporation. In 1923, he joined the Alabama Power Company where he served as engineer, assistant superintendent of distribution, superintendent of distribution, operating manager, operating vice-president, vice-president and general manager, and director. At Alabama Power Company, Mr. Robinson has been responsible for engineering studies and decisions required for the economic expansion and operation of the company. He has directed studies of appropriate combinations of hydro and steam generating capacity for various stages of the company's development, the design of integrated river systems of hydro plants, and economic construction and operation of interconnections with other companies. His responsibilities have included major engineering decisions for the location, characteristics, and design of new steam-electric and hydroelectric generating stations, and the organization of procedures and methods for operating the Alabama Power Company. In 1955, Mr. Robinson became a consultant for the company. He is a registered professional engineer in the State of Alabama. Mr. Robinson has served on the Power Generation Committee (1956-57).

William Knox Sonnemann (AM '38, M '43), manager of relay engineering, Westinghouse Electric Corporation, Newark, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for his contributions to design, development, and application of protective relays for electric power systems." Mr. Sonnemann was born in Port Lavaca, Tex., December 15, 1902. He graduated from the University of Texas in 1924 with a B. S. degree in E. E. After graduation, he spent a year in the Westinghouse Graduate Student Training Course. He then worked as relay engineer, meter engineering department, Westinghouse Electric Corporation. In 1929, he joined the Texas Power & Light Company as switchboard designer. From 1933 to 1935, he served as assistant office engineer for the Texas State Highway Department. In 1936, he returned to Westinghouse as design engineer, becoming senior design engineer in 1941. He was named section manager, relay section, engineering department in 1952, and manager of engineering, relay department in 1955. Mr. Sonnemann's contributions in the field of protective relaying include the development of the variable percentage differential principle, both in theory and in practice. He holds 27 U. S. patents and is the author of several technical papers that have appeared in *The Electric Journal*, AIEE *Transactions, Westinghouse Engineer*, and *Electric Light and Power*. From 1941 to 1947, Mr. Sonnemann taught graduate level courses in the Westinghouse Graduate Study Program in co-operation with Stevens Institute, New York University, and Brooklyn Polytechnic Institute. Mr. Sonnemann has served on the following AIEE Committees: Relays (1947-57, chairman 1956-57); and Power Division (1956-57).

Earl Walter Tipton (AM '28, M '36), section manager, Westinghouse Electric Corporation, Sharon, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for his many contributions to the fundamental knowledge and the development of transformer design." Mr. Tipton was born in Kansas City, Kans., March 23, 1902. He received a B. S. degree in E. E. from the University of Kansas in 1925. With the exception of a few months in the Westinghouse Student Course and at East Pittsburgh, Pa. Mr. Tipton's entire 31-year career has been spent at the Sharon Plant of Westinghouse Electric Corporation. In 1930, he was placed in charge of a special development group in the Power Transformer Division and in 1931 he was made responsible for a development group to design a new line of dry type current transformers on the standard part plan. In 1932, he was appointed section engineer in charge of an engineering section for order interpretation and design of core form distribution and network transformers. From 1936 to 1941, he served as section engineer in charge of large power transformer development where he carried out an investigation of high voltage insulation for core form transformers. In 1941, he assumed his present position as section en-

gineer in charge of the development group of the Network and Power Division. During his career, Mr. Tipton has written technical articles on transformers which have been published in *Electrical Engineering*, *Electric Journal*, and *Westinghouse Engineer*. He has been active in the Sharon Section of the AIEE, serving as Program Committee chairman, 1946-47; secretary-treasurer, 1947-48; and chairman, 1948-49. Mr. Tipton is a registered professional engineer in the State of Pennsylvania.

AIEE PERSONALITIES

J. W. Barker (M '26, F '30), chairman of the Board and president of the Research Corporation, has been elected president of Engineers Joint Council (EJC) for 1957, and **F. S. Black** (AM '34, M '44), publisher and editor of *Electrical World* magazine, has been elected vice-president of EJC. Dr. Barker is a graduate of Massachusetts Institute of Technology (MIT) in electrical engineering. He served as professor at MIT and at Lehigh University, and later as dean ot engineering, Columbia University. He left the latter position to serve as special assistant to the Secretary of the Navy from 1941 to 1945. In 1945, he became president of the Research Corporation. Dr. Barker is a member of the American Association for the Advancement of Science, American Society of Mechanical Engineers, American Society of Chemical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, and the American Society for Engineering Education. Mr. Black, born in Bryson City, N. C., is a graduate of the University of North Carolina with a B. S. degree in E. E. He is also a graduate of the National University Law School and holder of a masters' degree in patent law. Since 1945, he has been active in various capacities with the AIEE, and has also been a member of the Board of Directors and chairman of the Planning Committee of EJC. From 1948 to 1954, he was editor-in-chief of *Electrical World*, his previous association being that of assistant to the president, Potomac Electrical Power Company, Washington, D. C.

A. V. Loughren (M '36), vice-president in charge of research, Hazeltine Corporation, Little Neck, N. Y., has joined Airborne Instruments Laboratories, Inc., Mineola, N. Y., as vice-president in charge of research. Mr. Loughren was born in Rensselaer, N. Y., on September 15, 1902. He attended Columbia University where he received a B. A. degree in 1923 and an E. E. degree in 1925. From 1925 to 1930, he worked in the Research Laboratory of the General Electric Company, Schenectady, N. Y. In 1930, he joined the RCA Manufacturing Company, Camden, N. J., where he remained until 1934. He then returned to General Electric in the radio receiver engineering department of the company, Bridgeport, Conn. In 1936, he joined the Hazeltine Corporation. There, he served as engineer in charge of television development until World War II. He then became design supervisor responsible for the design of various radar identification equipment. Later, he became chief engineer in charge of civilian and Government design work. In 1949, he began to conduct a program of work in color television for the firm. He was then made vice-president in charge of research for the Hazeltine Corporation and executive vice-president of Hazeltine Research, Inc. Mr. Loughren is a Fellow and junior past president of the Institute of Radio Engineers; a Fellow of the Radio Club of America and of the Society of Motion Picture and Television Engineers.

E. S. Lee (AM '20, M '28, F '30), editor of the *General Electric Review*, has retired after more than 40 years with the General Electric Company. Mr. Lee, a past president of the AIEE (1948-49), was born in Chicago, Ill., on November 19, 1891. He attended the University of Illinois where he received the B. S. degree in E. E. in 1913. His M. S. degree in E. E. was obtained from Union College in 1915. Following graduation from the University of Illinois, Mr. Lee joined General Electric in Schenectady, N. Y., as a student engineer on the Test Course. He then became an instructor at Union College. During the summer months, he also served as an engineer in what is now the General Engineering Laboratory of the General Electric Company. From June 1916, when he left Union, to September 1917, Mr. Lee was a mechanical expert with the Locomotive Stoker Company, Chicago, Ill. After serving in the U. S. Army during World War I, he returned to General Electric in 1919 as division engineer of instruments and measurement in the General Engineering Laboratory. After working as assistant engineer and then engineer, Mr. Lee became executive engineer when the company merged the General Engineering and the Consulting Laboratories. He continued as head of the Laboratory until February 1, 1951, when he was appointed editor of the *General Electric Review*. He is a Fellow of the American Society of Mechanical Engineers; senior member of the Institute of Radio Engineers; member of the Instrument Society of America; member of the New York State Society of Professional Engineers and the National Society of Professional Engineers; member of the American Society for Engineering Education; and a past chairman of the Engineers' Council for Professional Development. Mr. Lee is author of numerous papers, some of which have been presented at general and district meetings of the AIEE, and most of which have appeared in different technical magazines. He has served on 19 national committees of AIEE, and has been chairman of 6 of these for one or more years. He has been a member of two coordinating committees and 10 special committees. He served as AIEE representative on the National Research Council, the Engineers Council for Professional Development, of which he was chairman from 1944 to 1946, the United Engineering Trustees, Inc., and the American Participating Committee for the Sixth International Congress for Applied Mechanics, held in Paris, France, in 1946. In addition to serving as director of AIEE from 1933-37, and as vice-president of District 1, 1940-42, Mr. Lee has been a member of the Newcomen Society of England—North American Branch, the American Society for Testing Materials, and the American Standards Association. He is also a member of Sigma Xi, Tau Beta Pi, and Eta Kappa Nu honor societies and, in October 1954, was made an Eminent Member of Eta Kappa Nu.

A. V. Loughren

E. S. Lee

OBITUARIES

Mortimer Freund (AM '07, M '12, Member for Life), member of the firm, Eadie, Freund, and Campbell, Consulting Engineers, died recently. Following his graduation as an electrical engineer from Columbia University in 1906, Mr. Freund gained experience with the Westinghouse Electric and Manufacturing Company from 1906 to 1907. He was next employed at the Brooklyn (N. Y.) Navy Yard until 1910. He then joined the staff of P. R. Moses where he was in responsible charge of consulting engineering problems. In 1914, he joined with J. G. Eadie and J. K. Campbell to form the consulting engineering firm of Eadie, Freund, and Campbell. This partnership lasted unchanged for 42 years until his death. The firm designed complete utility systems for buildings of all types.

Charles Rufus Harte (AM '10, M '32, F '46, Member for Life), consulting engineer (retired). The Connecticut Company, died

November 13, 1956. Mr. Harte was born in Marietta, Ohio, on November 8, 1870. He was graduated from Columbia University in 1893 with a degree in civil engineering. After graduation, he was employed by the New York, New Haven and Hartford Railroad where he remained until 1901. He joined Stone and Webster in 1901, returning to the New York, New Haven and Hartford Railroad in 1904 as assistant engineer. In 1910, he joined the Connecticut Company as construction engineer, remaining there during the rest of his career. Mr. Harte was a member of the American Society of Civil Engineers; an honorary member of the Connecticut Society of Civil Engineers and the American Transit Association. He was also active in the American Standards Association (ASA). Mr. Harte served on the following AIEE Committees: Standards (1923-39); U. S. National Committee of the International Electrotechnical Commission (1929-51); Standards Council, ASA (1949-56); and liaison representative on Standards Committee (1951-54).

Arthur Rhode Kaufmann (AM '53), separations engineer, American Telephone and Telegraph Company, died recently at the age of 58. Mr. Kaufmann was born in Olney, Ill., and was graduated from Purdue University in 1920 with a degree in electrical engineering. After graduation, he joined the American Telephone and Telegraph Company and held various assignments in equipment engineering, plant extension work, and inventory and costs. At the time of his death, his responsibilities were in connection with telephone revenue separation procedures. Mr. Kaufmann was a U. S. Navy veteran of World War I and was a member of Tau Beta Pi and Eta Kappa Nu.

Ernest Bruce Morrison (AM '45), electrical engineer, Oregon Insurance Rating Bureau, Portland, Ore., died recently. Mr. Morrison was born in Morrison, Okla., on October 24, 1897. He was graduated from Oregon State College in 1920 with a B. S. degree in E. E. After graduation, he joined the Oregon Insurance Rating Bureau where he remained throughout his career. During his many years with the Bureau, some of his duties included acting as representative for Underwriters Laboratories, Inc., at the Portland, Ore., office, and representing the Portland office at the meeting of the Electrical Council of Underwriters Laboratories. He also did considerable city grading work which consisted of inspection of the fire protection facilities of cities and towns in connection with the application of the National Board of Fire Underwriters schedule for the "Grading of Cities and Towns with Reference to Their Fire Defences and Physical Conditions." Mr. Morrison was a registered professional engineer in the State of Oregon.

George Webster Saathoff (AM '08, M '26, F '30, Member for Life), consulting engineer, New York, N. Y., died recently at the age of 72. Mr. Saathoff was born in Litchfield, Ill. He was graduated from the University of Illinois in 1906. After a training period with the Westinghouse Electric and Engineering Company, Pittsburgh, Pa., he joined the Cities Service Company where he remained for 35 years. He was vice-president and director of Electric Advisors, Inc., a subsidiary of Cities Service, until he started his own business in 1946. Mr. Saathoff was a Fellow of the American Society of Mechanical Engineers and a member of the Engineers Club of New York.

Arthur Eugene Watson (AM '03, M '15, F '37, Member for Life), Professor Emeritus of electrical engineering, Brown University, died recently at the age of 91. Prof. Watson was born in Providence, R. I., on March 4, 1866. He received his M. A. and Ph. D. degrees from Brown University in 1898 and 1905. After graduation, he became associated with the Thompson-Houston Electric Company in Lynn, Mass. When that company became part of the General Electric Company, he continued his work with them, transferring to the plant at Schenectady, N. Y. In 1895, he left to become an instructor in physics at Brown, where, successively, he held the positions of assistant professor of physics, assistant professor of electrical engineering, and associate professor of electrical engineering. Prof. Watson was the founder of the electrical engineering department at Brown. Many of his ideas and devices for effective teaching are still in use. In 1924, he designed the electrical plant for the airship *Shenandoah*. During the early days of the art he wrote several books on the construction of electrical machinery. Prof. Watson was a member of Sigma Xi, Phi Beta Kappa, and the Providence Engineering Society. He retired from teaching in 1938 but continued his active interest in the university, students, and engineering.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of November 15, 1956, recommended the following applications for transfer. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Ah, N. J., chief electrical engineer, Stephens-Adamson Mfg. Co., Aurora, Ill.
Anderson, E. M., associate prof., acting chairman, elec. engg. dept., North Dakota State College, Fargo, N. D.
Andrews, W. A., partner, Stover-Andrews & Co., Kansas City, Mo.
Bivans, E. L., senior engineer, Florida Power & Light Co., Miami, Fla.
Bond, H. E., division engineer, Underwriters Laboratories Inc., Chicago, Ill.
Bush, A. E., statistician & assistant controller, Detroit Edison Co., Detroit, Mich.
Cottell, J. B., president & treasurer, Continental Electric Equipment Co., Cincinnati, Ohio
Davis, E. M., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Dunn, T. E., consulting & application engineer, Westinghouse Electric Corp., Richmond, Va.
Fredrickson, E. H., designer, I-T-E Circuit Breaker Co., Philadelphia, Pa.
Graettinger, A. H., standards engineer, Allen-Bradley Co., Milwaukee, Wis.
Happel, W. J., manager, Westinghouse Electric Corp., Pittsburgh, Pa.
Hofma, R. E., associate engineer, Potomac Electric Power Co., Washington, D. C.
Johnson, C. L., electrical engineer, Rural Electrification Administration, Spokane, Wash.
Jones, A. R., senior engineer, Westinghouse Electric Corp., Pittsburgh, Pa.
Kern, H. O., sales engineer, Westinghouse Electric Corp., St. Louis, Mo.
Killian, T. J., deputy chief & chief scientist, U. S. Naval Research, Washington 25, D. C.
Knopow, H. S., president, Transformer Design, Inc. of Milwaukee, Milwaukee, Wis.
Knukle, R. W., manager of engineering, A. B. Chance Co., Centralia, Mo.
Longley, F. P. C., senior engineer, Pacific Tel. & Tel. Co., San Francisco, Calif.
Malo, J. M., division engineer, Central Power & Light Co., Corpus Christi, Tex.
Martin, J. W., supervisory engineer, U. S. Naval Ordnance Laboratory, Silver Spring, Md.
Martindale, H. C., sales engineer, Westinghouse Electric Corp., Spokane, Wash.
Mericle, M. H., instructor, electrical engineering dept., Iowa State College, Ames, Iowa.
Muller, J. W., electrical engineer, Western Electric Co., New York, N. Y.
Powell, M. J., aircraft electrical systems engineer, General Electric Co., Waynesboro, Va.
Rinclife, R. G., president, Philadelphia Electric Co., Philadelphia, Pa.
Ryan, M. W., assistant electrical engineer, J. G. White Engineering Corp., New York, N. Y.
Schmidt, W. S., staff consultant, Monongahela Power Co., Fairmont, W. Va.
Settle, A. G., electrical engineer, Fluor Corp., Los Angeles, Calif.
Thibodeau, A. J., manager, research & engineering, Ford Motor Co., Ypsilanti, Mich.
Tolbert, J. W., project engineer, Pennsylvania Power & Light Co., Allentown, Pa.
Wight, L. E., district manager, British Columbia Power Commission, Nanaimo, B. C., Canada.
Wittkopf, J. J., major group leader, Autonetics Div. of North American Aviation, Inc., Downey, Calif.
34 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before January 25, 1957 or March 25, 1957, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Anderson, C. H., transmission engineer, New York Telephone Co., Albany, N. Y.
Axtell, R. A., chief engineer, City Power Water & Gas Dept., Sheffield, Ala.
Barnard, C. F., chief engineer, Minnesota Pipe Line Co., St. Paul, Minn.
Bhatnagar, D. C., technical supervisor, Technical Development Establishment, Ministry of Defense, Govt. of India Estrela Batteries Ltd., P. O. Matunga, Bombay, India.
Delahooke, T. E., engineer, General Electric Co., Erie, Pa.
deWarga, J., technical counselor, Canadian General Electric Co., Peterboro, Ont., Canada
Dougherty, C. A., chief engineer, Jersey Central Power & Light Co., Asbury Park, N. J.
Dyer, L. C., plant manager, Kelsek Co., Norwood, Mass.
Fulmer, J. R., Jr., general manager, Clearfield Electric Coop. Inc., Clearfield, Pa.
Gillis, A. J., senior electrical engineer, Metcalf & Eddy, Boston, Mass.
Heiner, S. M., electrical engineer, Amalgamated Sugar Co., Ogden, Utah.
Hochdorf, M., mathematician, Tennessee Valley Authority, Chattanooga, Tenn.
Joseph, L. J., design engineer, Rotary Lift Co., Memphis, Tenn.
Liu, H. W., electrical engineer, Chemical Construction Corp., New York, N. Y.
Long, V. E., resident electrical engineer, Northrop Aircraft Corp., Palmdale, Calif.
Mulvaney, W., assistant superintendent of utilities, Magnolia Petroleum Co., Beaumont, Tex.
Nelson, K. M., division manager, Industrial Control Sales, Cutler-Hammer, Inc., Milwaukee, Wis.
O'Bryan, H. M., manager, Scientific Liaison, Sylvania Electric Products, Inc., N. Y., N. Y.
Opie, A., Radio transmission engineer, Southern Bell Telephone & Telegraph Co., Atlanta, Ga.
Richardson, J. S., chief electrical engineer, American Bridge Div., U. S. Steel Corp., Ambridge, Pa.
Riedy, K. F. R., maintenance engineer, U. S. Steel Corp., Munhall, Pa.
Ringger, L. J., general supervisor-electrical engineering, Columbia-Geneva Steel Div., U. S. Steel, Provo, Utah.
Robbins, F. J. (re-election), consulting electrical engineer, 209 W. Fifth St., Aberdeen, Wash.
Sandvold, H., fellow, Chr. Michelsen Institute, Bergen, Norway.
Snow, V. D., project engineer, E. I. du Pont de Nemours & Co., Inc., Aiken, S. C.
Spaeder, C. E., electromechanical designer, General Electric Co., Erie, Pa.
Sutton, E. L., electrical engineer, Rohm & Haas Co., Bristol, Pa.
Taylor, W. P., engineer, Baltimore Gas & Electric Co., Baltimore, Md.
Tyrrell, B. W., assistant superintendent-Communications Cable Engineering, Northern Electric Co. Ltd., Lachine, Que., Canada.
Wagner, V. W., member of technical staff, Bell Telephone Laboratories, New York, N. Y.
Whitehead, M. C., engineer, Oklahoma Gas & Electric Co., Oklahoma City, Okla.
Yeh, J. W., managing engineer, China Engineering & Trading Co., Hong Kong, China.
32 to grade of Member

ELECTRICAL ENGINEERING EDUCATION

AIEE in Fenn College

THE FENN COLLEGE AIEE Branch was established in February 1949, shortly after the electrical engineering curriculum was approved by Engineers Council for Professional Development in 1948. Prof. R. W. Schindler, chairman of the department, has served as branch adviser since its inception.

Initial membership exceeded 100 because of nearly 100 per cent enrollment of upper classmen. Present membership, including full-time students and a few Evening Division students who are pursuing a nine-year degree program while working full time, is down approximately two-thirds. However, prospects are that this number will increase because of the larger freshman and sophomore classes of the past two years.

This fall, the college enrolled its largest entering class of engineers. The 251 figure accounted for 60 per cent of the entering class and swelled the college's total engineering registration to 700, a 20 per cent jump over last year. Day Division majors in electrical engineering number about 125.

Courtesy Hastings-Willinger & Associates

District 2 Student Chairmen and Counselors Meet at Lafayette College

THE ANNUAL MEETING of the District 2 Student Activities Committee was held at Lafayette College, October 19-20, 1956. After the opening remarks by Prof. F. W. Smith, counselor, Lafayette College Joint Student Branch, as host counselor, the official college welcome was extended by Dr. R. C. Hutchison, president of Lafayette College. He spoke of the need for physical and administrative facilities to cope with modern engineering trends, and of the need for understanding of social relations and behavior among skilled technological men.

C. T. Pearce, vice-president, District 2, in his remarks to the members of the meeting, spoke of the ways in which the aims and objectives of the AIEE can be accomplished. These include rules and procedures, and the airing of problems in conferences, such as this annual meeting of Counselors and Student Chairmen.

The assembly was informed by W. B. Morton, chairman, AIEE Committee on Student Branches, of a resolution passed by the Board of Directors which states that the Student Branch Chairman must now be a member of the AIEE. The fact that the Student Activities Committee has now become a part of the Professional Development and Recognition Department of the AIEE was also mentioned by Mr. Morton.

At the meeting of Student Chairman, Donald Haring, chairman, Joint Student Branch of the AIEE and Institute of Radio Engineers (IRE), Lafayette College, presided.

L. L. Nonemaker, vice-chairman, Committee on Student Branches, called the student chairmen's attention to the student section in *Electrical Engineering* magazine, the booklet, "College Year," and the "Student Branch Manual." He reminded the meeting that it was the comments of students, to the Committee of Student Activities, which helped in formulating these publications, and they will grow only if the student members take an active interest in them.

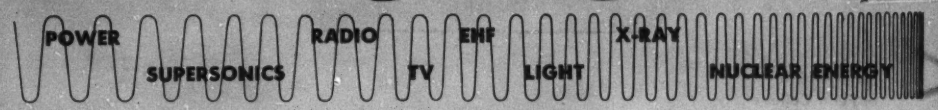
Edward Winklespecht, chairman, Committee on Student Activities, Lehigh Valley Section, spoke on two important subjects, student prize papers and group dynamics. Regarding student prize papers, Mr. Winklespecht first reminded the Student Chairmen meeting of the first and second branch prizes available. The first place winner receives $10, a certificate, and an expense paid trip with his Counselor to the District Prize Paper Competition. The second place winner will receive a certificate. In order to make a more equitable prize for second and third place winners, changes have been made in the prizes for District Competition. The first prize winner will receive $25 and a certificate, plus an opportunity to go to the Summer General Meeting in Montreal, Que., Canada; second prize winner will receive $25 and a certificate; and third prize winner will receive $15 and a certificate. In addition, the first three district prize paper winners will receive an all-expense paid two-day inspection trip to the Westinghouse Electric Corporation plant in Baltimore, Md. The winner of the National Prize Paper Contest receives $100. These incentives were added in the hope of greater participation in prize paper competition by the student members.

Mr. Winklespecht then introduced to the assemblage a new concept in the method of conducting a Student Branch meeting, which should result in greater participation by students at a meeting. This concept is called "Group Dynamics," and copies of "How to Run a Group-Dynamics Meeting" can be obtained by writing to the District 2 Secretary. An experimental Group-Dynamics meeting was set up among the student chairmen with successful results.

At the Counselors Meeting, presided over by Prof. F. W. Smith, the counselors were introduced to the changes in the prize paper awards by Prof. Thorstein Larsen, chairman, Committee on Student Activities. District 2.

D. R. Boone, secretary, District 2, informed the meeting that the chairman of the Committee on Student Activities must be a counselor. At this session, Prof. F. W. Smith of Lafayette College was elected chairman of the District 2 Committee on Student Activities for the term from August 1, 1957 to August 1, 1958.

It was decided that the next annual meeting of Student Chairmen and Counselors will take place in the Fall of 1957 at Swarthmore College with Prof. C. Barns as vice-chairman, District Committee on Student Activities; and the following year, 1958, at Pittsburgh University. The District Prize Paper Competition will be held at Villanova



THE COUNSELORS and Student Chairmen of District 2 held their meeting at Lafayette College, October 19-20, 1956. The group is shown in front of the Alumni Hall of Engineering.

University in the Spring of 1957 with Prof. J. Clothier as vice-chairman, District Committee on Student Activities; in 1958 at Delaware University; and in 1959 at Princeton University.

With the conclusion of the morning sessions, the members of the conference boarded a bus for a lunch at the Forks Township Volunteer Fire Company and an inspection trip of the Martin's Creek Power Plant as guests of the Pennsylvania Power and Light Company.

The annual dinner was held at Hogg Hall on the Lafayette College Campus. The speakers for the dinner were N. S. Hibshman, secretary, AIEE, who spoke on the obligations and responsibilities of electrical engineering students to the electrical engineering profession; and Dr. W. E. Brown, language department head, Lafayette College, whose talk on the Soviet Union was accompanied by color slides taken in the U.S.S.R.

The final General Session was held Saturday morning, October 20, 1956. W. B. Morton informed the assembly that questions to *Electrical Engineering* magazine must be sent in at least five weeks in advance of the publishing date. He also spoke of the purpose of the AIEE members as dedicating themselves to the advance of arts and sciences as well as to the engineer's professional development.

G. T. Pearce advised the assembly that the Student Branch's nomination for Counselor should be sent to his office by March 1. He stated that this was a nomination, not an election, and the nominee must be a corporate member of the AIEE.

The annual meeting was adjourned at 11 a.m., October 20, 1956.

9 Fellowships Awarded to Graduate Students by RCA

Nine university graduate students from New York, New Jersey, Connecticut, Illinois, Florida, and Wisconsin have received Radio Corporation of America (RCA) Fellowships for advanced studies in engineering and dramatic arts during the 1956-57 academic year, it was announced by Dr. C. B. Jolliffe, vice-president and technical director, RCA. These fellowships, with grants totaling $31,500, represent one phase of RCA's aid-to-education program which is now entering its 12th year.

Dr. Jolliffe, who is chairman of the RCA Education Committee, said that the purpose of the fellowships is to provide assistance for graduate students, at designated universities, who display outstanding ability in the sciences and arts related to the electronics industry. He added that more than 110 students have received the awards since 1947, when RCA Fellowships were inaugurated.

The annual grant of each RCA Fellowship is approximately $3,500. It includes full tuition costs, $2,100 toward the student's living expenses, and $750 as an unrestricted gift to the university attended by the RCA Fellow.

Seven of the fellowships are awarded for graduate study and research in physics, electrical engineering, and engineering physics. Two RCA-NBC Fellowships are awarded jointly by RCA and the National Broadcasting Company (NBC) for advance work in dramatic arts.

The recipients of RCA Fellowships and RCA-NBC Fellowships include graduate students enrolled at New York University, Columbia University, California Institute of Technology, Cornell University, University of Illinois, Princeton University, Rutgers University, Carnegie Institute of Technology, and Yale University.

Data Processing Center Established at UCLA by IBM

Establishment of the world's first university computer center devoted to the study of complicated business management problems has been announced by the University of California at Los Angeles (UCLA) and International Business Machines Corporation (IBM).

Called the Western Data Processing Center, it will be located on the UCLA campus but will be used by business researchers and students from colleges and universities in 11 western states. This project is a major step toward solving the growing shortage of business analysts schooled in the use of electronic computers.

The new center was made possible by a multimillion dollar gift from IBM, including the use of a *705* electronic data processing machine, a giant digital computer designed especially for business data and management problems.

The computer will be housed in its own research building, half the cost of which will be contributed by IBM.

The announcement was made by President R. G. Sproul of the University of California; Chancellor R. B. Allen of UCLA; and T. J. Watson, Jr., IBM president.

President Sproul described the new center as part of a program to establish two major computing centers of different types at the University's Berkeley and Los Angeles campuses to serve the rapidly growing needs of California and the West generally. The Berkeley center—heart of which is an IBM *701* computer—will be devoted chiefly to scientific problems.

Chancellor Allen announced that a number of colleges and universities in the Western states already have signified their intentions to become participating members in the educational and research center. Representatives of these institutions met at UCLA on November 19 to discuss how the computer's available time can best be utilized on a co-operative basis.

"This new research facility," Dr. Allen added, "will be used to speed the development of a vast new profession of business managers trained to use new techniques made possible by electronic computers."

Dr. C. C. Hurd, director of data processing machines for IBM, predicted that more than 10,000 large-scale digital computers will be in operation in the United States by 1966, and that more than 170,000 professionals must be trained to run them.

"That is a professional group larger than

the American Medical Association," he pointed out, "and we have less than a decade to build it up."

According to Dr. Hurd, the computer specialists must be educated to analyze business problems and translate them into machine language. They must gain a thorough knowledge of business organization, the art of decision-making, and of "how to think" on a computer.

The IBM *705* is capable of making 240,000 "decisions" in terms of true and false answers in 60 seconds. Engineered to handle business data, it can rapidly distill millions of figure-facts to determine the prime location for a retail store; simulate the complete operation of an oil refinery; handle a huge billing operation in minutes; furnish inventory and production control reports; or make up a 50,000-man payroll with millions of deductions.

The new Western Data Processing Center will be used to teach students how to apply advanced electronic computing methods to the most complex manufacturing and distribution problems faced by modern business management.

An advisory committee of representatives from participating colleges will be formed to establish priorities for problems submitted to the *705*. This committee will consider educational and scientific studies as well as business problems.

Dr. Allen said a full-time director of the center will be appointed soon and will work directly with the advisory committee.

IBM will install the machine and will contribute to the cost of maintaining it. The company will also make a substantial grant to support computer research assistants selected from graduate schools of western colleges and business schools accredited by the National Association of Collegiate Schools of Business.

These young research assistants will have college degrees in accounting, engineering, mathematics, logic, or the sciences. After training at the UCLA center, they will be able to teach electronic data processing courses at their own schools.

$5,000 Offered for Designs by Engineering Undergraduates

The James F. Lincoln Arc Welding Foundation of Cleveland, Ohio, has announced the 10th in its series of design competitions for college engineering undergraduates. The Foundation is offering $5,000 in cash awards to students and in scholarship funds to schools for undergraduate mechanical or structural designs in which arc welding is used. Actually, two separate competitions are offered, one in mechanical and one in structural designs. A total of 46 awards will be made, the highest being $1,250. Winners and their schools also receive national professional recognition.

Any resident college engineering undergraduate may compete by entering a design for a machine, machine part, structure, or structural part which makes a significant use of arc welding. Rules booklets are available free from The James F. Lincoln Arc Welding Foundation, Cleveland 17, Ohio.

Pratt Institute Announces New Engineering Curriculum

W. E. Wilson, dean of the Engineering School of Pratt Institute, has announced a new curriculum in engineering. Department heads have agreed on a common two-year curriculum for electrical, mechanical, industrial, and chemical engineering. Emphasis will be on mathematics and science without specialization, except for a minor amount in the junior and senior years. The advantages of this new system are as follows. Students, who usually are unequipped to decide their field of specialization in the first year of college, will not have to make up their minds for two years. Instructors can teach full sections instead of small sections, with a resultant economy in teaching costs which will permit hiring the best men. Eventually, all basic engineering science courses will be taught in one department. The third, fourth, and first graduate years will be taught by specialists, and a very much better grade of student will be prepared to enter the specialized department.

Commenting on the new curriculum, Dr. Wilson also expressed his anticipation that five highly competent men will be added to the teaching staff of the Engineering School each year for five years, and that the school's enrollment within the same period will rise to 600 undergraduate students and 100 graduate students.

An Electrical Engineer in Education

Courtesy F. C. Walters

W. C. DuVALL (AM '17, M '20, F '38, Member for Life), professor and head of the department of electrical engineering, University of Colorado, Boulder, Colo.

"Membership in the AIEE has meant a great deal to me, individually and as an educator. First of all, it stands for all the fine things in a noble profession. It is, so to speak, the guiding light that lights up the paths of professional dignity, professional progress, and inspiration. The AIEE through its many committees, its Winter General Meeting, Summer General Meeting, the District Meetings, and Section Meetings, affords one the opportunity to meet on a common footing the real leaders in the electrical engineering field. To me it has been a great satisfaction and real inspiration to have known such giants as C. P. Steinmetz, M. I. Pupin, B. G. Lamme, C. F. Scott, and many others who have passed on. This pleasure and profit could never have been enjoyed except through the activities of the AIEE. It is a great profession, and a great Institute and I am most proud to be affiliated with both."

Mr. DuVall attended the University of Colorado where he received a B.S. degree in E.E. in 1912 and an E.E. degree in 1922. He began his teaching career at the University of Pennsylvania, serving as instructor from 1915 to 1917 and as associate professor of electrical engineering from 1917 to 1919. He assumed this same position at the University of Colorado in 1919. He was appointed professor of electrical engineering in 1922 and head of the department of electrical engineering in 1941. He holds these positions at the present time. In 1956, he was named Professor Emeritus. During his career, Mr. DuVall has also worked for the Fairbanks Morse Electrical Manufacturing Company, Bell Telephone Company, and Southern California Edison Company.

Mr. DuVall's activities in the AIEE began when he was elected secretary of his student branch in 1911. He has served as chairman of the Denver Section and as some committee member of the Section since 1919. He was a member of the Convention Committee when the Summer Convention was held in Denver, Colo., in 1927. He served for 10 years as student counselor for the University of Colorado Branch, and as vice-president of District 6, 1949-51. Mr. DuVall has been a member of many AIEE national committees, the most recent being the Committee on Ethics and Committee on Research.

Electrical Engineering Education

POWER RADIO EMF X-RAY SUPERSONICS TV LIGHT NUCLEAR ENERGY

40 COUNSELORS, student chairmen, and other AIEE student officers representing 15 colleges in District 1 attended the fall student activities meeting at Worcester Polytechnic Institute.

Northeastern District Holds Student Activities Conference

The branch counselors and student chairmen from 15 colleges in District 1 held their first fall meeting on October 26, 1956, at the Worcester Polytechnic Institute (WPI), Worcester, Mass. The branches represented by their counselors and student chairmen were Clarkson College of Technology, the University of Connecticut, the University of Maine, Massachusetts Institute of Technology, the University of Massachusetts, the University of New Hampshire, Northeastern University, Norwich University, Rensselaer Polytechnic Institute, the University of Rhode Island, Tufts University, Worcester Polytechnic Institute, Yale University, and the affiliate branches at New Bedford Institute of Technology and Bradford Durfee Technical Institute.

Vice-President D. E. Garr addressed the conference after which Prof. W. R. Grogan of WPI, conference chairman and chairman of Student Activities in District 1, reported on an address given by Student Activities Chairman W. B. Morton at the San Francisco, Calif., meeting last summer.

The agenda included discussion of branch administration, district organization, AIEE publications, the prize paper competition, and the over-all problem of increasing student interest in the branches.

Courtesy General Electric Company

I. B. JOHNSON (center), member of the GE analytical engineering section, Schenectady, N.Y., is shown with M. D. Hooven (left), electrical engineer for PSE&G of Newark, N.J., and recent past president of the AIEE, and H. K. Sels, transmission and distribution engineer for PSE&G, at the opening session of a 30-week Power Systems Engineering Course the New Jersey utility has set up for its engineers.

EER Announces Annual Scholarship

The creation of a $2,000 annual scholarship for students of electrical engineering specializing in electronics has been announced by the Electronic Engineering Representatives (EER).

The purpose of the scholarship, according to EER president, Robert Asen, is to emphasize the vital and valuable services that sales representation and field engineering perform in the electronic community; and also to dramatize the advantages of an electronic field engineering career to young men interested in this science.

The EER scholarship is to be divided equally between a college in the territory served by the EER and a student who, in the opinion of the faculty, best deserves its benefits. For the 1957-58 academic year, the scholarship will be awarded to a student at New York University's College of Engineering.

The Electronic Engineering Representatives are an affiliation of independent field engineers and manufacturers' representatives. They are Burlingame Associates, Ltd.; Gawler-Knoop Company; G. Curtis Engel and Associates, Inc.; RMC Associates; and I. E. Robinson Company.

PSE&G Sets Up Course in Power Systems Engineering

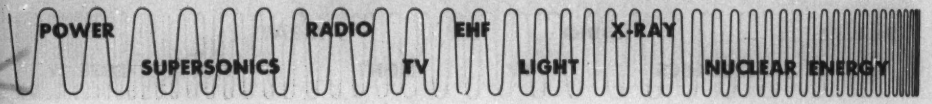
Recognizing the continuing need for more highly trained technical personnel, the Public Service Electric and Gas Company (PSE&G) of Newark, N.J., has begun a 30-week Power Systems Engineering Course for its engineers.

It is patterned after a similar course offered to a selected number of utility engineers by the General Electric Company (GE), according to H. K. Sels, transmission and distribution engineer of the company.

Instructors are men who have attended the General Electric course at Schenectady, N.Y.

The course, which meets weekly, got under way September 26, 1956, and will end May 1, 1957. It will include classroom instruction, seminars, and inspection trips.

The classroom instruction will consist of lectures in four fundamental power systems subjects: advanced circuit analysis and operational methods, power system



analysis, protective relaying, and surge phenomena.

Inspection trips will be made to nearby switchgear and meter works, substations, switching stations, and generating stations.

Guest authorities representing several electrical manufacturing firms and neighboring utilities will take part in seminars and informal discussions on such subjects as the subtransmission system, automatic load control, and transmission system design.

The size of the group taking the first course has been limited to 15. Subsequent classes may be somewhat larger.

Mr. Sels: M. D. Hooven, electrical engineer for PSE&G and recent past president of the AIEE; and I. B. Johnson, member of the GE analytical engineering section, addressed the opening session of the course.

Mr. Johnson stated that it represented the first time any company participating in the GE course has set up the course in entirety to teach it to its own employees.

University of Rochester Will Expand Division of Engineering

The University of Rochester announced that it will expand its Division of Engineering by adding a four-year undergraduate program in electrical engineering beginning September 1957. Students also will have the option of a five-year course in which they may obtain both a B.S. degree in E.E. and a B.A. degree with a major in a liberal arts field.

The university has conducted both undergraduate and graduate programs for over 40 years in mechanical and chemical engineering and, in 1952, introduced a graduate program leading to the Ph.D. degree in the latter field. During the fall of 1956, the graduate school began a master's degree program in electrical engineering under which practicing engineers may study for their advanced degree in evening classes in the University School of Liberal and Applied Studies.

The new course in electrical engineering is being undertaken as a major development of its engineering education and in response to the local and national needs of industry in the new age of automation and electronics, it was stated by Dr. L. D. Conta, chairman of the Division of Engineering and professor of mechanical engineering. The addition of electrical engineering to the programs in mechanical and chemical engineering will strengthen the teaching and research activities of the entire Division and also the research of other science departments, such as optics, physics, medicine, and psychology, which are increasingly dependent on electrical engineers. Dr. Conta pointed out that automatic controls and electrical measuring techniques are being used more and more in these research fields.

Grant of $1 Million Given to University of California

J. J. Hopkins, chairman of the board and president of General Dynamics Corporation, has announced that the corporation made a grant of $1 million to the University of California to assist in the expansion of the University's La Jolla, Calif., campus to provide for a graduate program in science and technology.

The corporation's Convair and General Atomic Divisions have headquarters in San Diego, Calif., and the Stromberg-Carlson Division has established its charactron tube plant there. The Regents of the University approved the expansion of the La Jolla campus on August 24. A special municipal election in San Diego June 5 made available city-owned land adjacent to Scripps Institution of Oceanography at La Jolla for the proposed center of research and teaching.

"As a graduate I have, of course, long followed with interest the cultural and scientific achievements of the University of California," Mr. Hopkins said in making the announcement. "I have become increasingly aware of the need to expand existing centers of advanced learning in the United States, and to create new centers. It is, I believe, fundamental to the cultural and economic welfare of the nation, and vitally necessary to our defense that we train greater numbers of first-rate scientists capable of undertaking advanced research on the frontiers of physical knowledge."

University President Dr. R. G. Sproul and Mr. Hopkins stated that this $1 million grant and its acceptance by the University was a recognition of the essential interdependence of modern American industry and universities. They hoped this pattern would set a trend for future university-industry relationships, resulting in a definite step toward solving the scientific manpower shortage.

AIEE-IRE Student Branch at Detroit Visits Power Plant

The joint Student Branch of AIEE-Institute of Radio Engineers (IRE) at the University of Detroit in Detroit, Mich., opened its fall activities with a field trip to St. Clair, Mich., to inspect the new St. Clair Power Plant of the Detroit Edison Company. The trip included a tour through the plant, a luncheon, and a talk on the electric power industry. Eighty members participated.

At the next meeting, the officers decided to have a "change of pace" from technical subjects and invited J. E. Vernier of Manley, Bennett, and Company, as the guest speaker to talk on stocks and bonds. The meeting was well attended and left the membership

New Bedford Students Receive Awards

TWO AWARDS were presented at the first annual dinner meeting of the Student Affiliate Branch of the New Bedford Institute of Textiles and Technology on October 22, 1956. E. E. Linden (right), chairman of the Providence Section, presents the Northeastern District Membership Award to Daniel Morrison (second from right), Branch chairman. Prof. Lenine Gonsalves (left), Student Branch counselor, presents an award for outstanding leadership and service to Joseph Costa (second from left), electrical engineering senior. Dr. J. E. Foster (center), president of the school, was an interested spectator.

with a new interest in the world of finance.

The guest speaker for the last meeting, on October 24, was L. R. Poker of the Allis-Chalmers Manufacturing Company. Wit' the aid of slides, he gave a very interesting talk on switchgear.

The Student Branch has laid great plans for the future months. Among them is the presentation of two half-hour television programs on Channel 56, a uhf educational channel operated by the University. There is also a trip planned to General Electric's lighting center, Nela Park, in Cleveland Ohio. Arrangements have been made to make it a two-day affair in March. Many other important events are still in the planning stage.

PENNSTAC Built by Pennsylvania State University

PENNSTAC, a general purpose automatic digital computer capable of solving a great variety of problems, has been placed into operation at the Pennsylvania State University.

It was built by the department of electrical engineering to facilitate educational and research work in the field of automatic computation and to furnish a computational service facility for research in other fields.

Much of the construction was accomplished by students and during the two years it was under construction it provided graduate thesis topics and classroom demonstrations for many students.

In the interest of stimulating education in the computer field, a number of industries made substantial technical and component contributions toward the construction of PENNSTAC.

Because PENNSTAC cannot process alphabetical information and because its current output equipment is not capable of high speeds, it is generally better suited for the scientific or engineering problem than for the business problem.

It can be used effectively for the solution of the classical problems of numerical analysis, such as solution of simultaneous equations, nonlinear equations, ordinary differential equations, and partial differential equations.

It can also be used effectively for the solution of some unusual problems which were first formulated and studied only in recent years, such as problems in game theory of stochastic processes.

Although some very large problems would be deterred by the finite capacity of the computer, the only limiting factor in most new problems is the ability to formulate a program for solution of the problem in terms of the elementary arithmetic and logical operations which the machine can perform.

Using a coded decimal system, PENNSTAC performs arithmetic and logical operations on numerical quantities which usually are represented by 10 decimal digits with algebraic sign. These operations are performed automatically under control of a program which has been prepared for the problem at hand. The program consists of a set of coded instructions which are stored in the memory of the computer along with the numerical quantities involved.

The memory, a magnetic drum, can be used to store 2,500 words where a word is either a numerical quantity or an instruction. Magnetic tape mechanisms being added to PENNSTAC can be used to supplement the magnetic drum memory. Input and output to the computer are accomplished by electric typewriters controlled by punched paper tape.

PENNSTAC is a fixed decimal computer, but for any given problem the decimal point can be set anywhere within the 10 decimal digits of the numerical quantities.

SOME OF THOSE PRESENT at the Annual Joint Banquet sponsored by the St. Louis Section for the Student Branches of Missouri University, St. Louis University, Washington University, and Missouri School of Mines and Metallurgy (MSM), were (*seated, left to right*) Prof. I. H. Lovett, department head, MSM; N. F. Rode, vice-president, District 7; R. C. Hase, St. Louis Section; (*standing, left to right*) Dr. C. M. Wallis, department head, Missouri University; Prof. William McCabe, counselor, St. Louis University Branch; Dr. R. J. W. Koopman, department head, Washington University and vice-chairman, St. Louis Section; Prof. C. J. Grimm, counselor, MSM Branch; J. J. Miller, General Electric Company, Banquet speaker; and Prof. Marvin Govro, counselor, Washington University.

Nebraska Students Hear Talk on New Automotive Developments

Dr. T. A. Boyd, associated with the General Motors Technical Center, addressed a group of about 200 students and professional engineers at the November Student Branch meeting held by the University of Nebraska. Dr. Boyd's talk, entitled "Your 1957 Model—I'd Like To See It," described some new developments in the automotive field and presented a challenge to young engineers to do creative work.

The meeting was jointly sponsored by the Student Branches of AIEE-Institute of Radio Engineers (IRE) and the American Society of Mechanical Engineers (ASME), with Nebraska Section members of ASME attending.

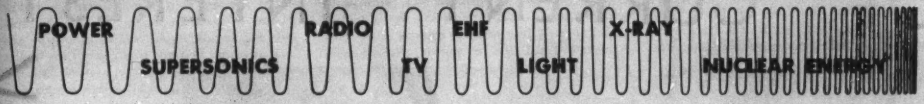
AIEE-IRE Student Branch at MSM Begins Active Year

The Missouri School of Mines Joint Student Branch, AIEE-Institute of Radio Engineers (IRE), has held two branch meetings, served as host for the St. Louis Section's annually sponsored banquet for the Branches of that Section, and sponsored a field trip for members to installations around Jefferson City, Mo.

On September 19, some 300 members and guests heard Irvin Mattick of Southwestern Bell Telephone Company, St. Louis, Mo., give a demonstration lecture on "Microwaves and Your Telephone." This meeting also served as a kickoff meeting for membership and to introduce new students and faculty to the members.

On October 10, about 175 persons came (in spite of the heavy flu epidemic) to hear Roger Lewis of Weston Instrument Company in his demonstration lecture on Electrical Instrumentation.

October 26, there were 90 persons from



the St. Louis Section, and Student Branches of Missouri University, St. Louis University, Washington University, and the Missouri School of Mines gathered in the College Inn of the Hotel Edwin Long for the annual Joint Banquet, sponsored by the St. Louis Section. The speaker was J. J. Miller of the General Electric Company, St. Louis, Mo., who spoke on "The Engineer Prepares for Management." Vice-President N. F. Rode, of AIEE District 7 was an honored guest at the banquet.

The next morning 40 students, accompanied by the AIEE Counselor, left at 6:30 a.m. for an all-day inspection trip, including visits to the Missouri Highway Patrol's main radio communications center, the High Ridge microwave repeater station of Bell Telephone Co., and Station KRCG-TV, all in the Jefferson City, Mo., area.

Many interesting meetings are scheduled for this year.

EJC Issues Report on "Engineering Faculties"

With 85 per cent of the engineering colleges understaffed by more than 10 per cent, the nation's engineering deans are taking steps to alleviate manpower problems of engineering faculties by supplementing regular salaries with research opportunity, consulting work, and summer employment.

This emergency treatment of the situation, according to a report released by Engineers Joint Council (EJC) entitled "Engineering Faculties," is becoming a definite pattern in faculty employment practices, to help meet competition for qualified engineers.

According to the report, colleges not only permit, but encourage faculty to take summer employment in industry, often developing specific programs with co-operating companies. When summer sessions in the colleges are scheduled, many faculty members increase their income by as much as one-fourth of their base salary.

"Many deans with important research contracts," the report continues, "feel that they cannot hold their current staffs or have any hope of expansion if they could not offer ample facilities and opportunities for individual research, both basic and applied."

In commenting on the general manpower problems of engineering faculties, the deans emphasized that there was a danger of oversimplifying the manpower problem by studying only numerical deficiencies. What many deans fear is the "insidious gradual deterioration" of the staff at the very time that engineering education is facing its greatest task.

The report is the result of a survey during the first quarter of 1956 of deans of accredited engineering colleges representing more than one half of the total engineering education staff in the United States. Statistical information includes data on Supply Demand and Salary Structure of Faculties, according to academic grade, and geographical location. Copies are available from Engineers Joint Council. 29 West 39th St., New York 18, N. Y.

Student Activities Committee of District 11 Meets in Akron, Ohio

On October 12, the District 11 Student Activities Committee met at the University of Akron. There were representatives from all nine colleges and universities in the district. During the morning, the student chairmen and counselors met separately for two hours and then met jointly for two hours. Branch operation and prize paper competition were two items discussed.

Leon Nonemaker and Joseph Rittenhouse both of the national committee on student activities were present, as well as H. H. Kerr, the District vice-president, and N. L. Danforth, the District secretary.

The afternoon was devoted to an inspection trip of the B. F. Goodrich Co. A dinner was held in the evening at which John Grotzinger, manager of the electrical engineering department of the Goodyear Tire & Rubber Co., gave a talk entitled "The Electrical Engineer in Mass Production Industry."

Student Recognized for New Mathematics Method

D. H. Wordell, an electrical engineering major at Bradford Durfee Technical Institute, Fall River, Mass., received official recognition of a new method of solving certain inequalities, a subtopic of algebra, with the publication of his article, "Solutions for Absolute Inequalities" in *School Science and Mathematics*, October, 1956 issue.

Before being approved, the new method was reviewed and tested by three professors of mathematics in various parts of the country. It also has been accepted by the Mathematics and Physics Club at the University

Mr. Wordell, a junior at Bradford Durfee is a member of the Student Affiliate Branch of the AIEE at the Institute.

New Members of Tau Beta Pi

Courtesy Pratt Institute Publicity Office

AT THE ENGINEERING SCHOOL of Pratt Institute, David Sarnoff (F '51), chairman of the Board of Directors of the Radio Corporation of America, and Fred Tanner, president of Precision Instrument Equipment, were inducted into Tau Beta Pi, the National Engineering Society. Both are alumni ". . . who have conferred outstanding honor on their school by achievements in the field of engineering." Among those present at the induction were: *(left to right)* F. H. Horn, president of Pratt Institute; Mr. Tanner; W. A. Paulson, student president of the Pratt Institute, or Lambda Chapter, of Tau Beta Pi; Gen. Sarnoff; and A. W. Doll, chairman of the department of physics of Pratt Institute.

OF CURRENT INTEREST

ENGINEERS inspect the forced-water cooling system that controls temperature in the Battelle research reactor which provides facilities for experiments requiring large amounts of neutrons and gamma rays. The isotopes produced in it are used in other experiments as well as in activation analysis, neutron diffraction, and shielding experiments. The reactor went critical in October 1956.

Nuclear Research Center Now Complete with Pool Reactor

THE NATION'S FIRST privately owned Nuclear Research Center was announced recently by Dr. Clyde Williams, president, director of Battelle. The announcement followed initial "start-up" of the Institute's one-million-watt research reactor.

The $750,000 reactor is the largest of the "pool type" yet to be put in service in this country. It is designed exclusively for research purposes. It becomes the third major new unit which has been added to the Battelle Nuclear Research Center in the past 13 months.

Just over a year ago, radiation laboratories were completed, Dr. Williams pointed out. In February of this year, Battelle announced completion of a laboratory for reactor development.

The newly completed reactor, according to Dr. H. R. Nelson, who directed development of the new Research Center, uses solid uranium-235 (U-235) fuel. The core, composed of fuel elements and boron control rods, is suspended 22 feet below the surface in a large pool of highly purified water. The water serves as the coolant and as a shield to protect personnel from the radiations. It is expected that the reactor will be operated 24 hours a day, six days a week. It was designed by Battelle physicists and engineered and built by the American Machine and Foundry Company.

Battelle's Nuclear Research Center, states Dr. Nelson, was built in anticipation of the large expansion of nuclear research as a result of the Atomic Energy Act of 1954, which permits private industry to enter upon commercial development of the atom. The Center makes available to industry complete facilities for peacetime nuclear energy studies.

The new reactor is basically a nuclear apparatus for producing gamma rays and nuclear particles called neutrons. These two products will be used in research to further chemical, metallurgical, electronic, and other technologies.

Technical Description

The design of Battelle's reactor was conceived with the aim of creating a research tool having extreme versatility and flexibility, because Institute scientists anticipated that, in a field as young as atomic science, the types of research to be explored would be very numerous. The reactor design enables Battelle technologists to perform experiments on all sorts of materials under many conditions with both neutrons and gamma rays present and with either type of radiation independent of the other.

Experimental conditions can be arranged to include static irradiation of solids and liquids at room temperature and pressure, irradiation of solid specimens at high temperatures and in a specified medium, and irradiation of fluids in a dynamic system allowing for such conditions as heating and circulation.

The Battelle research reactor, together with the hot-cell and critical assembly laboratories, is housed in a three-story building, 72 feet wide by 100 feet long. The two-section, water-filled pool in which the reactor core is suspended is approximately 20 feet wide by 40 feet long by 28 feet deep.

The core, composed of fuel elements and boron control rods, takes up a space about 1 x 1.5 x 2 feet at the bottom of a support column which is suspended from the movable control bridge. The core operates at full power in either of two positions. One position is in the approximate center of the pool, where bulk shielding and other large experiments may be performed. The other position is in a stall at one end of the pool, in front of beam tubes and the graphite thermal column. A second movable bridge, with a support column extending downward to the level of the core face, is used for supporting instruments and specimens adjacent to the core.

Cooling, shielding, and controls are all designed for continuous operation at power up to one mw (1,000 kw).

Two 8-inch and four 6-inch diameter beam tubes extending from the outside vertical walls of the pool through to the face of the core are among the locations

where specimens or experiments may be placed to utilize neutron or gamma radiation. At the one megawatt level of power, the approximate radiation fluxes are 10^{13} n/cm²-sec for fast and thermal neutrons and 5×10^{13} photons/cm² sec gamma flux.

A second major location for irradiation is the graphite column that provides two 4-foot openings with a thermal neutron flux of 5×10^{6} n/cm²-sec. One of the special features of Battelle's reactor is that access to the thermal column is possible through a horizontal as well as a vertical face.

For fast irradiation of relatively small specimens, the reactor is equipped with a special "weasel tube." This will operate hydraulically to carry two-inch diameter specimens to and from the core face with a minimum exposure time of about two seconds. Finally, for large experiments, the core may be moved to the center of a 20 x 20 x 28 foot pool area where bulky apparatus may be brought close to its face.

Other parts of the reactor laboratory are a radiation counting room, instrument repair room, and a 10-ton overhead crane.

The reactor fuel elements are composed of a uranium-aluminum alloy clad with 2S aluminum. The uranium in the alloy is enriched to 90 per cent U-235. There are 10 fuel plates in each element and a total of 35 elements containing, in all, 5.2 kilograms (about 11.5 pounds) of uranium-235. The 28 standard fuel elements contain 162 grams of uranium-235 each, while the two partial elements (used for fine adjustments in fuel loading) contain 81 grams each. The five special elements in which the control rods operate contain about 100 grams each. Depending on core geometry, which is flexible, approximately 2.6 to 3.6 kg (5.7-6.6 pounds) of U-235 are used to achieve criticality—nuclear fission. At a power level of one mw, roughly one gram of U-235 is burned up each day.

Specifications for the reactor were prepared under the direction of Dr. S. L. Fawcett and J. W. Chastain, Jr., working with their associates on the Battelle staff.

The U. S. Atomic Energy Commission has issued Battelle a 10-year license to operate its research reactor. The license dates from August 5, 1955, the date of the construction permit issued to Battelle.

Transistor Inventors Awarded Nobel Physics Prize

THE MOST HIGHLY COVETED award in the world is given annually by the Swedish Royal Academy. On November 1, 1956, the names of the winners of the Nobel Prize in Physics were announced as Dr. W. H. Brattain, Dr. John Bardeen, and Dr. William Shockley. The award was made to these three men because they were instrumental in the "investigations on semi-conductors and the discovery of the transistor effect."

The three winners will each receive a gold medal and diploma, and will share the $38,633 prize money.

The discovery of the principle of transistor action was the result of fundamental research directed toward gaining better understanding of the surface properties of semiconductors. An intensive program on the properties of germanium and silicon was undertaken at the Bell Telephone Laboratories following World War II. Dr. Shockley was in charge of the project along with S. O. Morgan.

In this program, one group engaged in the study of the body properties of semiconductors, whereas the other group studied surface properties. The theoretical physicist was John Bardeen. R. B. Gibney was the chemist for both of the groups. Extensive use was made of the knowledge and techniques developed by scientists both at the Laboratories and elsewhere in these investigations which resulted in the invention of the transistor. Others of particular assistance were R. S. Ohl, J. H. Scaff, and H. C. Theuerer, all members of the Laboratories staff.

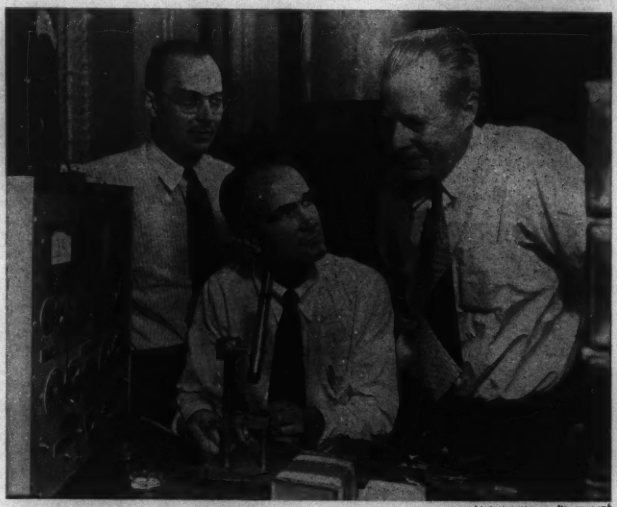
Since the time that the transistor was developed and announced approximately eight years ago, it has become increasingly more important in the "new electronic age." Recent developments and improvements of transistors and semiconductor devices have increased the possible fields of application of these to the extent that it may truly be stated that they have "revolutionized the electronics art."

The invention of the transistor, the basis for the Nobel Prize in Physics award, represents outstanding research teamwork as well as individual achievement, which has meant much to the rapid development of modern communications systems.

Dr. Brattain received a B.S. degree from Whitman College in 1924, an M.A. degree from the University of Oregon in 1926, and a Ph.D. degree from the University of Minnesota in 1928. His early work with the Laboratories was in the field of thermionics, especially the study of electron emission from all types of hot surfaces. Frequency standards, magnetometers, and infrared phenomena were some of the other studies he made. These subsequently led to his study of electrical conductivity and rectification phenomena in semiconductors. At Columbia University, during World War II, he was associated with the National Defense Research Committee which was working on magnetic detection of submarines. He has received many honorary degrees, medal awards, and is a Fellow of the American Academy of Arts and Sciences.

Dr. Bardeen received a B.S. in E.E. and an M.S. in E.E., in 1928 and 1929 respectively, from the University of Wisconsin. In 1936, he received his Ph.D. degree in mathematics and physics from Princeton University. Following a period when he was assistant professor of physics at the University of Minnesota, he joined the Naval Ordnance Laboratory during World War II, as a physicist. In 1945, he became research physicist at the Bell Laboratories, primarily dealing with the theoretical problems in solid-state physics, which included studies of semiconductor materials. Dr. Bardeen has received many honorary degrees, medal awards, and is a Member of the National Academy of Sciences.

Dr. Shockley received a B.Sc. degree in 1932 from the California Institute of Tech-



Bell Laboratories Photograph

NOBEL PRIZE WINNERS, Drs. John Bardeen, William Shockley, and W. H. Brattain *(left to right)* shown at Bell Telephone Laboratories in 1948 with apparatus used in the first investigations that led to the invention of the transistor. The trio received the 1956 Nobel Physics award for their invention of the transistor, which was announced by the Laboratories in 1948.

nology. In 1936, he received a Ph.D. degree from the Massachusetts Institute of Technology. Solid-state physics and semiconductors have been Dr. Shockley's forte. His work on electron tube and electron multiplier design, studies of various physical phenomena in alloys, radar development, and magnetism is well known. Dr. Shockley has many honorary degrees, medal awards, and is a member of the National Academy.

Nation-Wide Long-Range Radar Network for Air Traffic Control

A SWEEPING PLAN for improvement of the nation's air traffic control system was announced recently by the Civil Aeronautics Administration (CAA). An order for 23 long-range radars, biggest single purchase of electronic equipment in the agency's history, was placed.

The radars are the heart of a CAA plan announced last April by Secretary of Commerce Sinclair Weeks. The plan is designed to handle a fourfold increase in U. S. air traffic with minimum delay and maximum safety. These radars will help CAA controllers accomplish this improvement by scanning the skies for all aircraft up to 200 miles away, depending on size and altitude.

Equipment Installation

The equipment will be designed and built by the Raytheon Manufacturing Company of Waltham, Mass., at an approximate cost of $9 million.

These radars will be installed at 23 major cities.

Information from military radars will be used by CAA at five of these locations. CAA and the military are now studying which locations can best be served in this manner.

The 23 radars ordered will be part of an expanding coast-to-coast traffic control network of more than 70 civil and military radar installations. The network will give controllers a picture of aircraft from 15,000 to 70,000 feet in virtually all the U. S. airspace, and of aircraft at lower altitudes on densely traveled routes.

Thus, radar will serve to track the civil and military jets which move at 600 miles an hour or more in the higher altitudes, and the conventional aircraft traffic using the lower altitudes.

This is considered to be another giant step in preparation of the Federal Airways for the jet age. By 1959, civil jet transports will be in operation, and the Government intends to be ready with a system of traffic control that will insure safe separation and expeditious movement.

Type of Radar

Each radar uses a giant 40-foot antenna, and effectively covers more than 125,000 square miles of area. A single set will be able to feed up to 15 different monitor screens simultaneously, so that each controller on duty in a CAA center can have a picture of traffic movement. At present, with the exception of the radar-equipped New York and Washington centers, CAA controllers depend on position reports radioed in by pilots en route. CAA also has radar for surveillance around 34 airports, which will continue to serve approaching and departing traffic within a range of up to 30 miles.

The ability of the radars to detect and track aircraft in rain and other bad weather —which frequently causes excessive "clutter," or visual interference, on the radar viewing scope—is an important advantage of the equipment. This benefit is obtained through the flexibility of the system which permits the operator to select either linear or circular polarization of the radar signal, depending upon weather conditions.

This feature of the equipment enables linearly polarized radar, which often is unable to "see" targets in storm clouds because target and clouds both reflect the radar beam, to "see." To eliminate this handicap, the antenna of the new radar can apply circular polarization to the outgoing beam, which roughly is like putting "english" on a billiard ball. When these "twisting" microwaves strike the storm-cloud, millions of spherical raindrops bounce them back to the antenna with a reverse twist. Their path to the receiver is blocked by an electronic filter so that they cannot register on the radar scope. When the microwaves strike the irregular surfaces of a solid object such as an airplane, many of them return to the antenna retaining their original twist. Thus, they pass unhindered through the electronic filter to the receiver and register as the actual targets on the radar scope.

Another feature of the new radar system which contributes to its visual clarity is an improved "moving target indication," a built-in ability to select only moving objects, by filtering out reflections from fixed objects, such as buildings, mountains, and other undesirable reflections, from the radar viewing screen. This characteristic enables the operator to pick out aircraft in flight on his screen clearly and quickly.

Map Feature

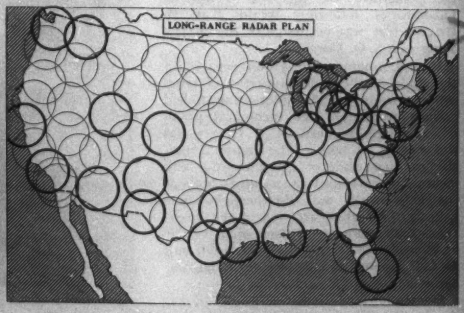
It is necessary, however, for the operator to pinpoint the exact geographical location of the plane at all times. This is accomplished by a newly developed system which makes it possible for the operator to flip a switch to superimpose onto the face of the radar scope an electronically generated map of the territory over which the plane flys.

The 16-inch sloping panel direct viewing scopes for the controllers are the largest of their type ever used by the CAA.

Chances of a breakdown of the radar coverage are reduced because the equipment has been constructed, in effect, as two systems in one, with dual controls and functioning parts permitting uninterrupted operations through either system.

The system "criticizes" its own operations through monitoring devices which operate automatically and continuously to keep operators informed at all times of the radar's working efficiency, and let them know where there may be trouble should it develop.

RADAR OPERATORS SCAN SKIES tracking aircraft up to 200 miles away. Shown on scope are air lanes connecting cities. Planes appear as light spots or pips. Electronically projected map overlay on scope enables operator instantly to pinpoint a plane's position.



RADAR INSTALLATIONS at 23 of the 28 areas in heavily outlined circles on map will be integral part of CAA's expanding coast-to-coast traffic control network. Light circles indicate future coverage. Radars will help CAA in its plan to handle fourfold increase in U. S.

Around the World in Ninety Minutes

"AROUND THE WORLD in Ninety Minutes," is obviously plagiarized, with slight modification,* from Jules Verne's "Around the World in Eighty Days," published in 1873. This is a magnificent yarn about Phileas T. Fogg and his French valet, Passepartout, who by virtue of an extravagant bet, made a journey from London completely around the world in 80 days with 10 minutes to spare. The journey was quite an accomplishment with the then available means of transportation. With Verne's title brought up to date for 1956—a 90 minute circumnavigation—it becomes rather obvious that the proposed scientific satellite is to be discussed.

On the opening day of the Washington Ball Park 1956 baseball season, the scientists were almost robbed of the distinction of establishing the first man-made satellite. President Eisenhower was there and, although no one could see him for the newspaper photographers, his presence stimulated superlative performance. The longest, fastest, highest, and most thrilling home run in history was hit by Mickey Mantle. To those present, it was evident that a velocity of only a few more feet per second could have established the ball as an orbiting satellite.

International Geophysical Year Program

To emphasize that this satellite program is a part of and a contribution to a truly international scientific experiment and not for military purposes is this intent. It is part of the over-all investigative program of the International Geophysical Year (IGY) and is entirely for the peaceful advancement of our scientific knowledge of the earth and its environment.

The IGY is a series of scientific experiments and observations involving the concentrated efforts of many nations of the world during the period from July 1, 1957, to the end of the calendar year 1958. That is the kind of year many have looked for—one which has been extended 50 per cent by the stroke of a pen.

Through the efforts of certain international scientific bodies, the program for this present IGY was set up in 1954 under the general jurisdiction of a Comité Special pour L'Année Géophysique Internationale (CSAGI). The IGY program covers almost all facets of the earth sciences and all regions of the globe from pole to pole, through the equatorial regions. During the initial planning, it appeared to many of the international scientists that something was lacking and that the time was now ripe for advancing our knowledge of that region of the earth which extends beyond what we normally call the atmosphere. Hence, the CSAGI adopted the following resolution:

> "In view of the great importance of observations over extended periods of time of extraterrestrial radiations and geophysical phenomena in the upper atmosphere, and in view of the advanced state of present rocket techniques, it is recommended that thought be given to the launching of small satellite vehicles, to their scientific instrumentation, and to the new problems associated with satellite experiments; such as, power supply, telemetering and orientation of the vehicle."

This formal presentation of the problem constituted a challenge to which various individuals and organizations in the United States responded. The result is the satellite program of the United States within IGY.

Forty-five nations are represented and are participating in the scientific work of the complete IGY program. Each of these countries has its own national committee which plans for, co-ordinates, and guides its portion of the activity in the over-all international effort. The United States' National Committee is headed by the well-known physicist and avocated football coach, Dr. Joseph Kaplan, of the University of California at Los Angeles.

Because of the magnitude and importance of the satellite program, it is receiving special attention in the American IGY activity. The over-all United States' responsibility for the program rests with the National Academy of Sciences and the National Science Foundation. For planning and coordinating this very important project, the United States National Committee set up a Technical Panel on the Earth Statellite Program within the National Academy of Sciences. This technical panel is headed by Dr. R. W. Porter of the General Electric Company (GE), a former president of the American Rocket Society.

The quoted CSAGI resolution was a noble resolve for a noble experiment, but there is a great gap between dreams and reality. Although scientists and engineers recognized that the state of the art of rocketry had advanced almost to the state where the launching of a satellite might be possible, it was obvious that the knowledge and resources required for physical realization of the launching resided only in certain national military establishments. This was true particularly in the United States. This posed several problems inasmuch as it was essential that the scientific program be international in character and free of any element of secrecy. The various problems involved were considered carefully by the United States Department of Defense, the National Academy of Sciences and other agencies. As a result, the United States, in the summer of 1955, accepted the challenge; and the Department of Defense set up a program to contribute in a substantial way to this satellite program. Their responsibility is to provide the means for launching the satellite body and for determining whether or not an orbital path has been achieved and maintained. In terms of dollars and effort, this is the major part of the program. Simply getting the satellite on an

*Revised text of an address by C. C. Furnas given at the Fall Meeting of the American Rocket Society in Buffalo, N.Y., on September 25, 1956.

Future Meetings of Other Societies

IRE-ASQC-RETMA, 3rd National Symposium on Reliability and Quality Control, January 14-15, Hotel Statler, Washington, D. C.

SPE, 13th Annual National Technical Conference, January 16-18, Hotel Sheraton-Jefferson, St. Louis, Mo.

National Motor Boat Show, January 19-27, New York Coliseum, New York, N. Y.

National Bureau of Standards, joint IRE Symposium on Very Low Frequency Electromagnetic Waves, January 23-25, Boulder NBS Laboratories, Boulder, Col.

Industrial Instrumentation, 8th Annual Southeastern Symposium, January 23-25, University of Florida, Gainesville, Fla.

IRE, Symposium on Microwave Ferrite Devices and Applications, January 28-29, Engineering Societies Building Auditorium, New York, N. Y.

Many Body Problem, Nuclear Compounds, January 28-29, Stevens Institute of Technology, Hoboken, N. J.

Plant Maintenance and Engineering, 8th Annual Conference and Show, January 28-31, Cleveland Public Auditorium, Cleveland, Ohio.

Institute of Aeronautical Sciences, joint IRE meeting, Electronics in Aviation Day, January 30, Sheraton-Astor Hotel, New York, N. Y.

3rd Annual Midwest Welding Conference, joint Armour Research Foundation of IIT and American Welding Society, January 30-31, Illinois Institute of Technology Chemistry Building, Chicago, Ill.

ASEE, 9th Annual College—Industry Conference, January 30-31, University Extension, University of California, Los Angeles, Calif.

Pennsylvania Electric Association, Winter Meeting:

- *Transmission and Distribution Committee,* January 31-February 1, Penn Harris Hotel, Harrisburg, Pa.
- *Hydraulic Power Committee,* January 31-February 1, Brunswick Hotel, Lancaster, Pa.
- *Electric Equipment Committee,* February 7-8, Benjamin Franklin Hotel, Philadelphia, Pa.
- *System Planning Committee, Systems Operation Committee,* joint Meeting, February 14-15, Benjamin Franklin Hotel, Philadelphia, Pa.

American Society of Heating and Air-Conditioning Engineers, 66th Annual Meeting and 2nd Exposition, February 1-5, Dallas, Tex.

26th Annual Midwinter Conference, Public Utility Buyers' Group, February 3-5, The Brown Hotel, Louisville, Ky.

ASTE, Committee Week, February 4-8, Benjamin Franklin Hotel, Philadelphia, Pa.

National Auto Accessories Exposition, February 4-8, New York Coliseum, New York, N. Y.

Western Winter Radio-Television and Appliance Market (Div. Western Home Goods Market), February 4-8, Western Merchandise Mart, San Francisco, Calif.

The Society of the Plastics Industry, Inc., Reinforced Plastics Division, 12th Annual Technical and Management Conference, February 5-7, Edgewater Beach Hotel, Chicago, Ill.

Nucleonics in Industry, Special Conference, AMA, February 7-8, Hotel Statler, New York, N. Y.

Symposium on Recording Heart Sounds, February 14, University of Buffalo Medical School, Buffalo, N. Y.

NSPE, Spring Meeting, February 15-16, Hotel Francis Marion, Charleston, S. C.

National Photographic Show, February 16-24, New York Coliseum, New York, N. Y.

orbit is not the end objective, and the Department of Defense does not dominate the program and will in no way interfere with the international, geophysical, and the scientific objectives. A few details of the launching equipment and program must, for military reasons, remain classified. Aside from these, however, the entire program is unclassified, and full information is, or will be, made available to the international scientific community. The United States military establishment is enthusiastic in its co-operative role. To aid in guiding the scientific aspects of this program, a Technical Advisory Panel of prominent, selfless, scientists headed by Dr. H. J. Stewart, of the California Institute of Technology are on hand.

Project *Vanguard*

The over-all program for launching the satellite is designated as Project *Vanguard*, and the responsibility for carrying it out rests in the Office of Naval Research with Dr. J. P. Hagen, of the Naval Research Laboratory (NLR). The U. S. Air Force and the U. S. Army have made major contributions in both funds and effort. Developing and producing the necessary equipment is the Glenn L. Martin Company (GLM). GE is developing the first-stage launching-vehicle rocket motor. Other major components suppliers are: (1) Aerojet-General Corporation for second-stage propulsion and tankage; (2) Alleghany Ballistics Laboratory and Grand Central Rocket Company for third-stage development; (3) Minneapolis-Honeywell Corporation for the inertial guidance system; (4) Vickers Corporation, Electric Division, for magnetic amplifier development and the servo system; (5) Atlantic Research Corporation for development of third-stage spin and retro motors; and (6) Polarad Electronic Corporation for ground-controls test equipment.

The developmental team headed by NRL and GLM is further augmented by the work of some 30-odd minor components suppliers.

History

Because launching a satellite obviously is a task for rockets, a history of pertinent background developments in that field would seem to be appropriate.

Available records show that the Chinese were the first to use something resembling rockets in the form of "fire arrows" in the year 1232 A.D. and, of course, the "rocket's red glare" in the national anthem and the rockets of the yesteryear 4th of July celebrations are familiar to all. But, apart from speculation, theoretical consideration, and considerable dreaming, there was very little actual advance in rocketry between the 13th Century and the beginning of the 20th Century.

A major landmark came in 1919 when Dr. R. H. Goddard of Clark University published "A Method of Reaching Extreme Altitude." This represented a report on his pioneer work in liquid-fuel rockets. Also, the magnificent technical accomplishment of the V-2 rocket in World War II demands recognition. This development was very completely and interestingly described by Dr. Walter Dornberger in 1954 in the book "V-2." Dr. Dornberger, in technical association with Dr. Wernher Von Braun, had a great deal to do with the V-2 development.

Space Travel Fantasies

In more recent works the names of Dr. Von Braun and his associate writers—Dr. Joseph Kaplan, Dr. F. L. Whipple, Willie Ley, Heinz Haber, and Oscar Schachter—stand out prominently as authors of such books as "Conquest of the Moon," "Across the Space Frontier," and others.

On the speculative side obeisance must always be given to Jules Verne's book of 1865, "A Trip to the Moon." This excited public imagination and undoubtedly stimulated many embryonic scientists from that day to this.

Johannes Kepler, the first man to discover the exact laws governing the movements of the planets—the same laws which some day will govern the movement of space ships—wrote in the later part of his life (but did not publish) his version of science fiction entitled "Somnium." The profound Kepler, for lack of fuel, was forced to transport his hero to the moon by supernatural means. The book was finally published in 1634.

In 1656 the ingenious Cyrano de Bergerac wrote "Voyage to the Moon and Sun." To Cyrano goes the credit for first proposing rocket propulsion for the purpose, though certainly he had no idea of its advantages, and, surprisingly, he anticipated the ramjet.

From the time of the Greek satirist, Lucian, in 160 A.D., to the present, there have been numerous writings on outer-space travel; but one writer, in compendiums on the subject who has failed to treat the subject is Mark Twain. Although his story of "Captain Stormfield's Visit to Heaven" is primarily wit and philosophy, the fiery old gent, on Earth a San Francisco sea captain, gets in a bit of traveling by heading for the hereafter on a comet. He observes that, although his path is direct, the movements of other comets are all methodical and in the form of a giant lasso. He encounters a new unit of measurement, the *Kazark!* One kazark is the exact equivalent, in bulk, of 169 earths like ours. After many tribulations and much misdirection, Stormfield arrives at his proper entrance to the Universal Heaven only to learn to his chagrin that the chief clerk in charge of entrance requirements has never heard of his world called "Earth." Finally, as so often happens, an obscure aide, who has the mental habit of storing bits of knowledge, volunteered that there was such a place, but that in the Universal Heaven it was referred to as the "Wart." Stormfield allowed that it was all right for the young clerk to say that in Heaven, but he wouldn't advise going to Earth and repeating it!

Space Travel Facts

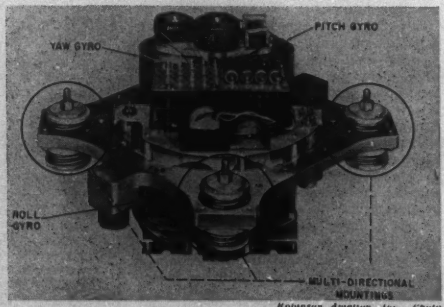
Returning to the year 1956, a large number of serious scientists and engineers are convinced that there now is enough basic knowledge and almost enough know-how to make the longed for dream of centuries finally come true—the launching of a vehicle which, because of its position and oriented velocity, will be able to circle the earth more or less indefinitely. It will be a small moon; it will be a satellite; it will be extremely valuable scientifically; and it will eventually lead to tremendous practical benefits to the human race.

To those who are at all familiar with the various difficulties and complications involved, the program is by no means simple. The plan is to put a very small object in that portion of the skies above the atmosphere. This task, however, is one of the most difficult ever undertaken by a body of scientists and engineers.

The objective of the program is to launch an instrumented body, scientifically useful in obtaining certain physical measurements, in an orbital path above the sensible atmosphere of the earth sometime during the IGY. There is a reasonable probability that the schedule will be met, but there is no true assurance of success. The program, as it now stands, encompasses the use of six preliminary rocket systems for test purposes, to be followed by six complete rocket guidance-and-control systems which will have as their objective the launching of a satellite on orbit at least 200 miles above the surface of the earth. If this program is completely successful, we will find that before the end of calendar 1958, six instrumented scientific satellites will have been launched and maintained for greater or lesser periods in an orbital path above the sensible atmosphere of the earth.

Satellite Details

The probability that all six of these will be completely successful is very small. However, the probability of getting at least one into the orbital position is quite good. Only



Reaction Aviation, Inc., Photo

PROJECT VANGUARD for Earth Satellites will be the most important part of the IGY program. Three precision made gyroscopes are set in operation (12,000 rpm) and each retains a preset altitude with which the longitudinal, lateral, and vertical axes of the Vanguard Satellite rocket must be kept in unison. If the rocket veer from its course even a fraction of a degree, sensitive gyros instantaneously correct the course by relaying corrections through the engine mounting gimbal actuators.

time and the efforts of many scientists and engineers will give the final box score.

The satellite itself will be about 20 inches in diameter and weigh about 20 pounds. Actually, the present design weight of the satellite is 21½ pounds. The entire assembly, the complete *Vanguard* vehicle made up of the satellite and its three stages of rockets, will be about 70-feet long and 45 inches in diameter. The first stage will weigh approximately 17,800 pounds and will be propelled by a liquid rocket motor using liquid oxygen as the oxidizer and jet kerosene as fuel. This power plant will develop a thrust of about 27,000 pounds.

At take-off the *Vanguard* first will rise vertically. The launching rocket will then follow a programmed tilt in the direction of a chosen trajectory. One hundred and forty seconds will have elapsed by the first-stage burnout. The rocket will then be some 35 miles high and moving at about 45 degrees to the horizontal, with a velocity of 5,600 feet per second.

The first stage will then be discarded and the second stage will enter the picture. This will also be a liquid-propellant rocket. The oxidizer will be nitric acid, the fuel, unsymmetrical dimethyl-hydrazine. This second stage will also burn for about 140 seconds and, carrying in itself the third stage which bears the satellite toward the orbital altitude, will weigh approximately 4,770 pounds. Its burnout velocity, including the earth's rotation velocity, will be nearly 14,800 feet per second. All during the burning of this second stage, the rocket will continue to tilt more and more toward the horizontal. At the end of the burning, the second-stage combination will be about 140 miles high and will coast to a peak altitude of about 300 miles at roughly 700 miles from the launching point. The velocity at that point will be about 13,070 feet per second.

The inertial-guidance equipment, entirely in the second stage, will automatically orient the rocket with the proper attitude after burnout. When this orientation of the second and third stages has been completed, the third-stage rocket, consisting of a single solid-propellant cylinder, will be spun about its longitudinal axis up to about 100 to 200 revolutions per minute for gyroscopic stability. After the third-stage rocket is spinning and the peak of the trajectory has been reached, the second and third stages will be separated and the final stage will be fired. The final stage will impart roughly 50 per cent of the required velocity to the satellite itself. A short time after the end of the third-stage burnout, small retroactive rockets will cause the satellite itself and the third-stage rocket case to separate from each other, by a few feet a second.

The satellite then, if everything has gone well, will be on its course and ready to be observed or interrogated for scientific information. The velocity at this point is calculated to be about 26,470 feet per second. For a circular orbit of 300 miles in altitude, a velocity of 25,000 feet per second is required to hold the milk in the bucket. So that some velocity margin with which to work is available. Hence, the satellite will probably swing in an elliptical orbit of some 300-mile perigee (closest approach to the earth) and a 1,500 mile apogee (farthest distance from the earth). At this speed, and with this elliptical orbit, the satellite will circumnavigate the earth about every 90 minutes and will stay in that orbit until the resistance of the minute quantities of gases, or of any ambient solid particles in space, slows it down below the critical velocity about 25,000 feet per second. Then it will descend rapidly into the atmosphere of the earth and disintegrate harmlessly, ending that particular experiment. If the conditions of the upper atmosphere are as estimated by some scientists, the satellite may exist as long as a year. Moderate performance would be as much as a few weeks. The life depends largely upon the density of matter out beyond the sensible atmosphere. That extra-atmospheric density of matter is one of the unknowns about which scientists are curious. The satellite will give some answers.

Placing on Orbit

Placing the satellite on orbit calls for a very accurate orientation in relation to the surface of the earth. The amount of misalignment allowable depends upon the velocity, but, for the case in hand, the accuracy of alignment parallel to the tangent of the earth must be within 2.9° for the ellipse to 0° for the circle. This is a very fine attitude adjustment at a several-hundred-miles distance from the launching point, but those involved in the program have confidence that this degree of accuracy can be accomplished.

The *Vanguard* launchings will take place at the Air Force Missile Test Station at Cape Canaveral, Fla. It is planned that the orbit path will be inclined about 35° with respect to the equator. Hence, as the satellite progresses into multiple revolutions, and owing to regression of the nodes and the earth's rotation, all observation stations within an equatorial belt some 70° wide will be passed over. This represents a band of over 4,500 miles in width and should give many opportunities for observations and measurements in both the northern and southern hemispheres.

Observation and Tracking

Two classes both of scientific observation and tracking will be possible: first, optical observation of the satellite itself from ground stations and, second, the reception of transmitted radio signals from the vehicle. A small transmitter and a small battery power supply will be carried on board—enough to give out significant signals over a period of a few weeks, at least.

An important part of the measurements will be the determination of satellite position with respect to time at different parts of the earth. Depending upon the reflectivity, the satellite will have a brightness of the order of a fifth- or sixth-magnitude star and, if the location is known exactly for a particular time under very clear atmospheric conditions, it might be observable with a good pair of binoculars. It should be readily observable with a modest astronomical telescope, if one knows approximately where to look for it. Twelve prime astronomical observatory stations are being planned in different parts of the world with some 200 secondary stations. Thirty-five of these secondary stations are organized, and it is hoped that many other nations and amateur groups may enter into this program of physical observation. The best periods for optical observation will be about an hour after sunset and about an hour before sunrise.

The second means of determining position will be by transmitted radio signals from the satellite itself. These will be received by a "Minitrack" station (a system developed by the Naval Research Laboratory) which, by phase-comparison, will be able to determine position with a very high degree of accuracy. The Minitrack stations are also capable of receiving stored and coded telemetered scientific data from the satellite. Although this system is fairly expensive, development is under way for a relatively inexpensive Minitrack ground-receiving station. It is hoped that a reduced cost will be sufficiently low to induce many private groups throughout the world to build and man Minitrack receiving stations and, thus, contribute to the compilation of data on the satellite in its course. During the life of the satellite detailed predictions of its position versus time will be made public at frequent intervals.

VORTAC
Air Navigation System

New air navigation equipment, which can be combined with existing equipment to comprise a complete system that gives distance and direction information to pilots of fast commercial or private planes and which is of major importance to air safety, has been announced by the Federal Telephone and Radio Company, Clifton, N. J., a division of International Telephone and Telegraph Corporation.

Called VORTAC, it operates by transmitting very high frequency radio signals from a plane to a ground beacon station which automatically sends back to the plane both direction and distance information. Many planes can use a single beacon at the same time.

The VORTAC system combines TACAN (tactical air navigation), a military navigation aid, with VOR (very high frequency omnidirectional range), a commercial navigational aid currently used in the majority of commercial aircraft and in most private planes. The new equipment is a commercial version of military TACAN.

VOR gives a pilot information as to what direction he is flying with respect to a ground beacon station. TACAN gives a pilot directional information and also the distance from the ground station in miles or fractions of miles. Recently, for technical reasons, the Air Co-ordinating Committee approved a combination of the two systems, called VORTAC, for commercial and civilian use.

This is the first announcement of the development and availability of a commercial version of TACAN DME (distance measuring equipment) to be combined in a system with VOR, thus instituting VORTAC.

Pilots will know at all times where they are and the direction in which they are flying. Both factors are becoming more important to air safety due to the increasing speed of propeller-driven planes and the expected debut in the United States in 1958-59 of commercial jet air lines. The equipment will also permit operators of control towers to exercise better control of air traffic, which

is a vital aid at the various crowded airports.

The new unit does the same distance measuring job as military TACAN DME and is compatible with it in that it will not interfere with the other, is only half the size (½ ATR) of the military equipment, and weighs only 35 lbs. It is accurate to within 2/10 of a mile, independent of distance, up to 195 nautical miles.

Combined in the VORTAC system, it will permit the pilot to determine his distance from a ground station continuously and accurately from a meter closely resembling the mileage gauge of an auto speedometer. Direction is determined from a dial whose needle points out the plane's heading in degrees.

The integrated system makes it possible for an aircraft operator to use VOR equipment already installed in an aircraft by addition of the commercial TACAN DME equipment. The operator, thus, can obtain continuous distance information with respect to any one of the TACAN or VORTAC beacons.

Other available TACAN equipment for indicating direction can be added at any time to the commercial equipment to provide a complete system. Thus, economies may be realized by retaining VOR equipment now in use until such times as the VOR is to be replaced by the modern TACAN bearing system.

The VORTAC has direct crystal control of 126 transmitting and receiving frequencies, resulting in simplicity and stability; compact modular design exceeding all specifications and demands for easy service and maintenance; use of ARINC-type tubes where applicable, with no subminiature tubes employed; provision for multiple displays of range information; and construction in accordance with recommendations by the Airlines Electronic Engineering Committee.

Commercial TACAN DME consists of four essential units; a distance measuring interrogator, control box, distance indicator and antenna. To these may be added a TACAN bearing adaptor and bearing indicators. The circuitry, based on more than 10 years of distance measuring system experience, is the kind which has been used in actual flight over many hundreds of thousands of hours. All vacuum tube diodes have been replaced with silicon diodes, effecting substantial decrease in size and weight. Mechanical tuning arrangements have been simplified. Spurious emission has been greatly reduced.

The ATR Interrogator measures approximately 19½ x 7½ x 4¾ inches. It is suction cooled from a centralized system and provision is made for air blowers when no centralized cooling system is available. The Interrogator is designed to operate standard TACAN range indicator (*ID-310/ARN*). Where multiple displays are desired from a single interrogator, the major contents of the indicator are mounted in a 2-inch deep "dog house" which is on the front-panel and up to three remote displays may be driven from it.

The antenna is a broadband type with a low standing-wave ratio over the 960- to 1,215-mc band. Two types of antenna are available, projecting or flush. The projecting antenna offers the lightest weight, smallest cut-out in airframe skin and best electrical performance. The flush antenna has greater resistance to breakage during ground handling and less aerodynamic drag.

The control box measures approximately 2¼ x 5¾ x 4 inches and weighs 2 pounds. It provides selection of 126 channels, an OFF-STANDBY-ON control, and an IDENTITY TONE VOLUME control. Channel numbers are ⅜-inch high and panel lighting is white by day and red at night.

The range indicator measures approximately 3¼ x 3¼ by 7 inches and weighs 3 pounds. The ¾-inch high numbers are displayed on three wheels, numbered in units, tens, and hundreds of nautical miles. A red bar appears during search or loss of power. The range unit has a maximum range of 195 miles.

In announcing the new TACAN DME equipment, it was disclosed also that there are two test equipments for use with it. The first is a Bench Test Set weighing approximately 130 pounds and measuring 17 inches deep, 25 inches high, and 19 inches wide. When connected to the airborne interrogator this unit provides accurate measurement of receiver sensitivity on all channels, receiver frequency on all channels, receiver decoding, identity, and range tracking speed, inbound and outbound. The unit also tests range accuracy at 0, 24, 48, 72, 96, and 192 miles, or any intermediate distance.

The second test unit is a Ramp Test Set measuring approximately 7 x 9 x 11 inches and weighing 17 pounds. When placed within 30 feet of aircraft, this unit gives Go-No-Go checks on: transmitter power, transmitter pulse code, receiver sensitivity, receiver frequency at two frequencies, receiver decoding, range accuracy at two ranges, bearing accuracy, channel selector, and identity.

COMMERCIAL VERSION of TACAN can be used by itself to give distance and direction information, or a part of it may be used combined with VOR, to form a complete VORTAC air navigation system. *Left to right:* bearing adaptor; course indicator and radio magnetic indicator (either or both of which may be used); distance measuring equipment interrogator; range indicator; control box; and protruding type antenna.

Studies and Special Texts Offered at Various Institutions

American Society for Engineering Education. The annual midwinter meeting will include technical papers as well as inspection trips. The role of graphical methods in modern engineering procedures will be emphasized. This Engineering Drawing Division meeting is for engineering graphics teachers from colleges throughout the United States. It will be held at Rice Institute in Houston, Tex., January 30 through February 2.

Polytechnic Institute of Brooklyn. The seventh of a series of International Symposia, entitled "Symposium on the Role of Solid-State Phenomena in Electric Circuits," is to be held in co-operation with the IRE Professional Group on Circuit Theory, and the PG on Electron Devices, and cosponsored by the Department of Defense Research Agencies. It is to be held in the auditorium of the Engineering Societies Building in New York, N. Y., April 23-25.

The Pennsylvania State University. Workshops aimed at providing engineers and scientists with instruction and practice in preparing technical reports will be conducted at two seminars during 1957. Both will emphasize aspects of training; functions and use of illustrative material; nature and form of the technical report; pitfalls in grammar, mechanics, punctuation, and editing; and illustrating techniques used in technical reports. Dates for the two sessions are March 17-29, and September 16-27.

Office of Naval Research. In a cosponsorship with the Glenn L. Martin Co., the Office of Naval Research will hold an educational colloquium on Radiation Effects on Materials, to be held at Johns Hopkins University in Baltimore, March 27-29.

National Bureau of Standards. The U. S. Department of Commerce is sponsoring the Very Low Frequency Symposium to be held at the National Bureau of Standards Boulder Laboratories. It is hoped that those interested be there along with the more than 200 physicists from the United States and several other countries when the symposium is scheduled, January 23-25.

University of Pennsylvania. An Operations Research Symposium is to be held at the University Museum Lecture Hall. It is sponsored jointly by the Professional Group on Engineering Management of the Philadelphia Section of The Institute of Radio Engineers and the Society of Industrial and Applied Mathematics. The meeting is to be held on February 7.

X-Ray Microscope Detects Behavior of Metals

A powerful new tool for research into hitherto unexplored fields of metals, foods, chemicals and criminology, went on public display here for the first time yesterday when General Electric's X-ray Department unveiled its new X-ray Microscope at the National Metals Exposition held in the Cleveland, Ohio, Public Auditorium.

Under development for more than 4 years, the X-ray miscroscope promises to reveal hidden facts concerning such vital facts as

corrosion in metals, the effect of foreign materials in metals, the soundness of electroplated coatings, and the effects of various processes on the behavior and structure of metals.

Secret of the X-ray microscope lies in the extremely tiny size of the focal spot, which is bombarded by electrons and thus caused to give off X-rays. This target is only 40 millionths of an inch in diameter. X-rays emanating from such a small spot fan out in all directions and hence magnify any object through which they pass. The X-ray microscope achieves magnifications up to 1,500 times, and at the same time discloses the inner structure of the object being examined.

While not as powerful in its magnifying power as the electron microscope, the X-ray microscope has an advantage in that it does not require mounting the specimen in a vacuum and other special preparation techniques.

It has an advantage over the optical microscope in depth of focus which permits three-dimensional examination of the specimen. No special sectioning is required to prepare the specimen.

Its inherent advantage over both is that it penetrates to the interior of the object and reveals structures otherwise not visible.

The X-ray microscope may be used either for direct viewing or for recording the image on film. A Polaroid camera may be attached to produce an immediate record on film.

One of the major benefits brought by X-ray microscopy to the metalworking field will be the visualization of minute foreign particles in metals, which are ordinarily invisible because they are beneath the surface, or appear, to the eye, to be identical with the surrounding metal.

X-ray microscopy is also being studied for value in the field of foods, where it reveals the internal structure of processed foods and the effects of various processes on this structure. This will guide the research food scientist in developing better foods.

In the field of chemistry, X-ray microscopy will aid in studying contamination in chemicals; the deterioration of fibers and textiles; the depth to which dyes and adhesives penetrate; identifying plastics; surface changes due to weathering; and studying how well particles are distributed in a mixture or suspension. It offers the possibility of use in quality control of carbon black in the rubber industry.

In the field of criminology, it will aid in identifying minute particles of fabric, soils, and paints on objects found at the scenes of crimes.

Basically, this is how the X-ray microscope works: A narrow beam of electrons emerges from an electron "gun." This beam is cut down to desired size by a condenser lens, and then passes through an objective lens. The tiny beam then bombards the target made of a sheet of tungsten which is thick enough to stop the electrons but thin enough to permit the generated X-rays to pass through. The remainder of the instrument is a simple shadow projection microscope. That is, a specimen placed near the X-ray source casts an enlarged image on a fluorescent screen, where it can be viewed by the eye, or on a photographic film where the image is recorded.

The X-ray microscope was originally developed at the General Engineering Laboratory of General Electric Co., at Schenectady, N.Y., by Sterling Newberry and S. E. Summers and then engineered for production at the X-ray Department of General Electric in Milwaukee, Wis.

U.S.S. Ranger Gets Most Powerful Propulsion

The *USS Ranger (CVA-61)*, another addition to the U. S. Navy's increasing fleet of attack aircraft carriers, became the eighth vessel in the Navy to bear this name—but the most powerfully propelled of them all.

Equipped with propulsion equipment of sufficient power to drive more than 100 passenger diesel locomotive engines, the *Ranger's* shaft horsepower is greater than the combined propelling power of all *Ranger* predecessors.

Her turbines and reduction gears, like those aboard her sister ship the *USS Saratoga (CVA-60)*, are the lightest ever constructed in weight per horsepower for ships of this horsepower range, and have the highest horsepower rating of any engines ever installed aboard an American vessel. The propulsion equipment will develop over 200,000 hp—equal to that of the *Saratoga*, but greater than any other Navy combat vessel.

Both the *Ranger's* and the *Saratoga's* turbines use steam at the highest pressure and temperature conditions of any type combat vessel built for regular service for the Navy to date. Using newly developed alloys, the four cross-compound turbines and four double reduction gears in the *Ranger* are lighter and occupy less space than propulsion equipment in the largest World War II aircraft carriers.

When the *Ranger* and the *Saratoga* were designed, a requirement was made by the Navy that they must represent the last word in engineering perfection at completion. This objective made necessary the development of many new design features and production techniques. It was particularly true with regard to the propulsion equipment, which incorporates a radically new design for turbines and gears.

Both the turbines and reduction gears were designed and developed by the Navy and General Electric Company (GE) engineers. They were manufactured at the GE medium steam turbine, generator and gear department in Lynn, Mass.

For nearly a year U.S. Navy and GE engineers worked on the prototype designs and calculations of the *Saratoga's* and *Ranger's* propulsion equipment. In less than 24 months from the date of each order, all the propulsion turbines and the reduction gear sets were delivered to each ship.

The propulsion turbines for the *Ranger* and *Saratoga* are among the most efficient ever developed for the Navy. Lighter and more compact than World War II types, the turbines require less fuel per horsepower than World War II units, although they develop greater shaft horsepower. In addition, the new turbines will enable the *Ranger* to steam efficiently at full as well as at cruising speeds.

The alloy steel propulsion gears, which connect the turbines to the *Ranger's* four propeller shafts and reduce the speed of the highly efficient turbines to the necessarily slower shaft speed, are also of a modern lightweight design. Notwithstanding their size and rating, the gears are 50 per cent lighter over-all than if they had been built according to World War II design. The saving in weight means the *Ranger* can carry more aviation fuel and/or fuel oil for increased cruising range.

To meet the U. S. Navy Bureau of Ships specifications, the gears were accurately hobbed to a maximum tooth spacing variation of 0.0002 inches.

An over-all feature of this newly designed marine power plant is its compactness. Although propelling a vessel longer than three football fields and nearly one quarter as wide, the equipment is designed to occupy a relatively small amount of space.

Other GE equipment aboard this newest aircraft carrier includes: two 600-kw a-c turbine-generator sets to start the engines of the jet planes; three 1,000-kw generators for attachment to diesel engines for emergency electric power; circuit breakers, electric bus transfer equipment, and switchgear for the degaussing equipment; instruments for the main electric switchboard; controls for the oil purification equipment; motors to operate machine shop power tools; thrustors and the lighting contact panels; height finding, search and fire control radar, in addition to radio transceivers; and the height finding and search radar antennas, as well as the fire control equipment.

Similar propulsion equipment is to be installed on the three remaining attack aircraft carriers—*USS Independence (CVA-62)*, *USS Kitty Hawk (CVA-63)*, and the *CVA-64*, unnamed as of this writing.

Officers Elected by IRE for 1957

J. T. Henderson, principal research officer of the National Research Council, Ottawa, Ont., Canada, has been accorded one of the highest engineering honors with the announcement of his election as president of the Institute of Radio Engineers (IRE) for 1957. Dr. Henderson succeeds A. V. Loughren, color television consultant, as head of this international society.

Yasujiro Niwa, president of Tokyo Electrical Engineering College, Tokyo, Honshu, Japan, will succeed Herre Rinia, director of research of the Philips Research Laboratories in Eindhoven, Noord Brabant, Holland, as IRE vice-president.

Elected as directors for the 1957-1958 term are D. E. Nobel, vice-president in charge of the Communications and Electronics Division of Motorola, Inc., Chicago, Ill., and Samuel Seely, professor and head of the Department of Electrical Engineering at Case Institute of Technology, Cleveland, Ohio.

Regional Directors elected for 1957-1958 are: Region 2, F. A. Polkinghorn, Bell Telephone Laboratories, Whippany, N. J.; Region 6, Kenneth Newton, Component Parts Engineering, Bendix Aviation Corp., Kansas City, Mo.; Region 8, A. B. Oxley, RCA Victor Company, Ltd., Montreal, Que., Canada.

Control Board Directs Steel from Hot Strip Mill

A 48-foot panel which is part of a 62-foot motor control line-up was recently installed in one of the largest steel mills on the Eastern seaboard.

This tremendous panel unit was built by the General Electric (GE) Company, Schenectady, N. Y. It will control 80 motors which range in power from 1½ to 200 horsepower. These motors are used in a steel mill that manufactures various types of pipe for use in oil and gas pipeline applications.

Only a portion of this vast control board has been shown on the cover, but this section in the picture, along with another section that is not shown, will direct the steel from the hot strip mill into an electric weld pipe mill. At this point in the processing, the material from the hot strip mill will be cut into the exact dimensions of length and width desired.

After this precutting, the material is cleaned and processed in order to expedite the forming from flat sheet steel into the tube forms. These are then seam welded and trimmed. After softening by the process of induction annealing, conveyors carry these items through a myriad of cleaning and final inspection stations. Following the inspection, the finished lengths of pipe are all delivered to a shipping area where they are dispersed according to shipment orders on hand.

All of the manufacturing, inspecting, and shipment packing station-to-station transporting, is done automatically also by use of the gigantic control panel.

Liquid Metal Heated Steam Generator Model Shown

A scale model of a liquid metal heated steam generator is currently being shown nation-wide by its developer to engineers, research staffs, and developmental managers involved in reactor design and application. The device, developed for use in nuclear power generation systems, incorporates a number of operational and safety features particularly applicable to using hot liquid metals to generate steam from sodium or sodium-potassium cooled reactors.

One unique feature of the model's design is the double tube construction which, combined with double tube sheets, forms two barriers to separate the liquid metal from the water and steam generated. This is particularly important with alkaline metals, such as molten sodium, or sodium-potassium metals, since these metals react vigorously with water, forming the explosive gas hydrogen.

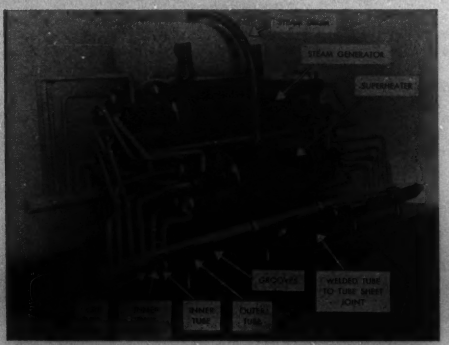
The heat is transferred from the hot liquid metal inside the chrome-molybdenum steel inner tubes welded into tube sheets which form a part of the head, of each unit. These inner tubes are expanded tightly into the outer tubes throughout the entire length of the outer tube and heat is transferred from the inner tube to outer tube by conduction. The outer tubes are welded into tube sheets which form a part of the steam chamber or shell.

Therefore, if either tube should break in service, or any tube joint should fail, the fluids would flow into an intermediate chamber formed between the two tube sheets. Fine grooves are formed on the outside of the inner, or liquid metal tube, or on the inner surface of the counter, or steam tube, forming passages to permit the flow of a monitoring gas into the intermediate space beetween tube sheets.

Tubes are welded to the tube sheets by a new automatic welding process that permits complete radiographic inspection of the completed joint.

Another feature of this design by the Griscom-Russell Co. is the practicability of monitoring the intermediate space between tubes and tube sheets with a gas so that very small amounts of leakage can rapidly be detected. The large steam evaporator, with the two nozzles leading to the steam drum, uses a patented insulated core tube and a bayonet design to reduce the thermal stresses caused by the difference in tube wall to shell plate temperatures. The small superheater located below the steam evaporator also has a bayonet construction with an inner core tube to guide the molten metal to the sealed end of the tube. In both units the hot metal returns in the annulus between the core tube and the inside wall of the inner or molten metal tube.

The model generator is being shown throughout the country. It was in a prominent position at the recent Trade Fair of the Atomic Industry in Chicago, Ill.



MODEL of liquid metal heated steam generator designed and developed for use in nuclear power generation systems.

Postdoctoral and Research Fellowships and Associateships

National Science Foundation. Plans to award 800 graduate and 175 postdoctoral fellowships for scientific studies during the 1957-58 academic year were announced recently. Subjects are: mathematics, physics, medicine, biology, engineering, anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and fields of convergence between the natural and social sciences. Graduate fellowships are available to those who are working toward the master's or doctoral degree in the first, intermediate, or terminal year of graduate study. College seniors who expect to receive a baccalaureate degree during 1956-57 are also eligible to apply. Postdoctoral fellowships are available to all those who have a Ph.D. in any of the fields listed, or who have had research training and experience of equivalent value. In addition, M.D., D.D.S., or D.V.M. degree holders are eligible provided they present an acceptable plan of study and research. Stipends are: $1,600, first year; $1,800, intermediate year; $2,000, terminal year. Postdoctoral fellowship stipend is $3,800. Married Fellows will get dependency allowances. Tuition, laboratory fees, and limited travel allowances will also be provided. Information and applications are available from: Fellowship Office, National Academy of Sciences-National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.

Oak Ridge Institute of Nuclear Studies. Applications are open for places in the 1957-58 Atomic Energy Commission Special Fellowship Program in Industrial Hygiene. The industrial hygiene fellowships leading to the master's degree are available to college graduates in engineering or the basic sciences. It provides for nine months of graduate training in the subject at Harvard University's School of Public Health or at the University of Pittsburgh Graduate School of Public Health. Courses in public health and biostatistics are necessary, and electives may include engineering, health physics, toxicology, industrial medicine, and related subjects. Stipends are $2,500 for the individual, $350 allowance each for spouse, and for each child. Fellowship awards include payment of normal tuition and fees required by the university, a travel allowance of six cents per mile for the Fellow (not dependents) from the point of application to the university, as well as assistance to attend the annual meeting of the American Industrial Hygiene Association. One or two years of graduate work or industrial experience may qualify a Fellow for an additional $200 in the basic stipend. Additional information and application blanks may be obtained from: Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn. A special two-week course in radiation chemistry for scientists interested and active in the field and for teachers of college and university graduate courses is scheduled for March 25 through April 6 and will include principal phases of radiation chemistry and physics with emphasis on basic principles rather than applications. Four-week courses are also available starting on the following dates: April 29, May 27, June 24, and Sep-

tember 9. Further information on these special courses may be obtained from Dr. R. T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.

Atomic Energy Commission. The AEC has established a program of special fellowships to encourage more students to pursue courses of study in the physical sciences and nuclear engineering. About 150 fellowships carrying stipends of $1,800 plus tuition and dependency allowances will be awarded under the administration of the Oak Ridge Institute of Nuclear Studies Graduate Fellowship Program. The fellowship allowances will be paid to students registered in or accepted by a college or university where a program of graduate study in nuclear energy technology has been developed which is comparable to the one-year course of study at AEC schools.

National Academy of Sciences–National Research Council. Postdoctoral resident research associateships have again been offered by the joint organization for the 1957-58 academic year at the Argonne National Laboratory, the National Bureau of Standards, and the Naval Research Laboratory. It also begins an associateship program at the Oak Ridge National Laboratory which will provide the unusual opportunity for advanced training in basic research in radio astronomy, statistics and mathematical biology, computer design, radiation and high-temperature chemistry, microwave component theory, semiconductors, numerical analysis, liquid metals, low temperature, solid-state and reactor physics. In addition, research in visual psychophysics and engineering psychology is available. Stipends run up to $7,035 per year. Further information and applications can be secured by writing to: Fellowship Office, National Academy of Science–National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.

Science Series New Entertainment Concept

The Science Series, which was launched with the telecast of "Our Mr. Sun" over the Columbia Broadcasting System (CBS) by the Bell System is a new concept in television entertainment. It combines entertainment and information in productions designed for public service use long beyond their short times on the air.

The long-range use of the programs is made possible by preparing them on color motion picture film, so that they can be exhibited on television or elsewhere for several years after their initial telecast. They are produced with much attention to fact and to detail so that their use may extend over a long period.

In deciding to produce this special series of science telecasts, the Bell System was motivated by its own deep interest in science, as well as its realization of the great importance of science in modern life. The series is designed to give the public a broader knowledge and understanding of what science is and how scientists go about their work. The Bell Telephone Companies hope that, by showing the drama and excitement of science, the company may help it to flourish and do even more for people everywhere.

Topics for the series will cover the broad range of modern science. While much of the information will be new, emphasis will be on the scientific knowledge rather than novelty.

"Our Mr. Sun," for example, gives a thorough and balanced picture of scientific studies concerned with the sun, including material on solar astronomy, solar physics, the uses of solar energy, and biological dependence on the sun. Leading scientists in solar studies collaborated in preparing "Our Mr. Sun," including Dr. Farrington Daniels, University of Wisconsin; Dr. Armin Deutsch, Mount Wilson and Palomar Observatories; Dr. D. H. Menbel, Harvard Observatory; Dr. W. O. Roberts, High Altitude Observatory of the University of Colorado; and Dr. Otto Struve, University of California.

The series is being produced under the general supervision of a Scientific Advisory Board. All are eminent American scientists, each selected both for his standing in his own field and for his interest in the problem of presenting scientific information in terms readily understood by the general public.

The fields of science represented on the Scientific Advisory Board include:

Anthropology—Dr. Clyde Kluckhohn, Harvard University

Bacteriology and Botany—Dr. P. R. Burkholder, Brooklyn Botanic Garden

Biology and Genetics—Dr. G. W. Beadle, California Institute of Technology

Chemistry—Dr. Farrington Daniels, University of Wisconsin

Engineering—Dr. Ralph Bown, former vice president for research, Bel Telephone Laboratories (*Chairman*)

Geophysics and Marine Geology—Dr. Maurice Ewing, Columbia University

Mathematics—Dr. Warren Weaver, Rockefeller Foundation (*Vice-Chairman*)

Medicine—Dr. J. Z. Bowers, University of Wisconsin

Physics—Dr. G. R. Harrison, Massachusets Institute of Technology

Frank Capra, the Academy Award winning movie director, was selected as the producer of "Our Mr. Sun" because of his interest in science and his special abilities in the field of informational films. He is a graduate of the California Institute of Technology in chemical engineering, and he supervised the production of the outstanding "Why We Fight" series of films for the U. S. Army during World War II. Animated cartoons in "Our Mr. Sun," were done by UPA Pictures, Inc., who besides their Academy Award-winning entertainment film ("Gerald McBoing-Boing" and "When Magoo Flew") have produced many factual movies. Co-ordinator on scientific aspects of the film was Assistant Producer Donald Jones, who is now associated with the Scientific Advisory Board in development of future programs.

Beyond "Our Mr. Sun," three more productions in the Bell System Science Series are already in work. Their subjects and their telecast dates will be announced later.

Cartoon by UPA Pictures, Inc.

MR. SUN is the hero of "Our Mr. Sun," the first program in the new Science Series telecast in color over the CBS network on Mondays. Mr. Sun tends to be boastful about his power and accomplishments, but he does not impress his constant companion in the one-hour show, Father Time.

Electronic Analyzer for Steam Generating Unit

An electronic system designed to analyze the operation of a giant steam generating unit in a few hours—a task ordinarily requiring weeks of work by a team of specialists—has been developed jointly by The Babcock & Wilcox Company (B&W) and The Bailey Meter Company.

By means of "sensing" elements linked to analog scanners, the system can probe hundreds of different boiler locations. At the touch of a button, it begins gathering such data as temperature, pressure, and gas composition. Complex electronic devices, operating without human guidance, then sort the information, supplement it with preset figures, and punch it in code on continuous tape.

Tape readings are transmitted by teletype to New York City, where B&W has a large electronic computer. Translated automatically into code suitable for computer use, the information is processed mathematically and transmitted back to the boiler site for application by engineers and technicians.

The new system has been developed to help engineers determine quickly and economically such boiler problems as sources of heat losses, the most efficient types of fuels, and when and where to remove combustion waste deposits. Emphasizing the need for a method of correcting material or operating faults promptly, B&W authorities pointed out that boiler malfunctions and abnormal fuel consumption may continue for weeks under ordinary trouble-shooting methods. They said that the system also represents an effort to conserve critically short engineering manpower by reducing the number of personnel and the amount of time required to conduct boiler analyses.

The "brain" of the system is a centrally located electronic co-ordinating unit developed at the B&W Research Center at Alliance, Ohio. A special "scanning" device created by The Bailey Meter Company of Cleveland, Ohio, makes it possible for the system to gather data from widespread points of a boiler. Each scanning unit col-

lects information from 25 different sensing elements. Any number of these devices may be hooked up with the system, depending on the quantity and location of points from which information is desired.

Recently the system underwent performance tests at the West Penn Power Company's Springdale, Pa., station, where it was used to gather data from 140 locations of boiler number 88.

Potentials of the new equipment will be more fully realized when it is applied later this year to the first of three steam generating units of a new type being built by B&W on the American Gas and Electric Company power system. This unit, located at the Ohio Power Company's Philo plant, near Zanesville, Ohio, will utilize the highest steam pressure and temperature ever employed in the commercial production of electric power.

Data will be gathered from 500 different locations of the Philo unit, compared with 140 at Springdale. Successful operation of the system on this unit will conserve both manpower and money during the boiler's "proving out" stage, and provide performance data of a type unobtainable in the past.

Spokesmen for The Bailey Meter Company, which plans to make the new equipment available commercially if it proves successful, said that the system has been designed primarily for the analysis of large steam generating units. They added, however, that it should be adaptable to smaller boilers or boiler elements, and capable of being moved readily from one boiler to another.

In future tests, officials of the two companies revealed, the system will be applied not only to boilers, but to a broad range of equipment used in conjunction with them. They said that the system may shed new light, for example, on the combined operating efficiency of turbines and auxiliary equipment used to produce and distribute electric power.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Equation Corrections

To the Editor:

My letter to the Editor was published in the September 1956 issue of *Electrical Engineering*, for which I thank you.

Unfortunately there are a few errors which need correction. On page 880, column 1, line 2 ends with a word millimicron. In my original I use letters m.u. (phys.) which is the approved abbreviation for mass unit (physical mass unit). Thus, the *millimicrons* should be *mass units*.

Other errors appear in the 2 formulas halfway down the column (lines 37 and 45) which read

$$m_m = m_o (1 - v^2c^2)^{-1/2}$$

and

$$E = m_o (1 - v^2c^2)^{-1/2}c^2$$

And should read as in my letter

$$m_m = m_o \left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

$$E = M_o \left(1 - \frac{v^2}{c^2}\right)^{-1/2} c^2$$

May I suggest that the printer's proofs be forwarded to the writers for possible corrections, regardless of how trivial the matter seems to be. Thank you again.

Very truly yours,

ERNST J. MOMMO (AM '15, M '24)
(Retired)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following annotations. Information for which is taken from the prefaces of the books in question.

AERODYNAMICS PROPULSION STRUCTURES AND DESIGN PRACTICE. By E. A. Bonney, M. J. Zucrow, and C. W. Besserer. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1956. 595 pages, 6 x 9-1/4 inches, bound. $10. The series, "Principles of Guided Missile Design," of which this is the second volume, is intended to provide engineers and graduate students with basic information on missile technology. The present volume consists of three sections. Section I, on general supersonic aerodynamics, deals with such problems as skin friction, shock waves, and loads, and contains material on wind tunnels, ballistic ranges, and flight testing. Section II discusses the thermodynamic and aerodynamic principles governing the operating characteristics of jet propulsion engines. Section III covers the design of the airframe and the packaging of its contents. Each section includes a bibliography.

ASTM STANDARDS ON RUBBER PRODUCTS (1956). Published annually by the American Society for Testing Materials, 1916 Race St., Philadelphia, Pa. 741 pages, 6 by 9 inches, paper. $5.75 Compiled into a single volume for convenience of reference, these standards cover processibility, aging, weathering, and low temperature tests; physical and chemical tests for vulcanized rubber; and specifications and methods of tests for such products as automotive and electrical rubber, electrical protective equipments, insulated wire and cable, and nonrigid plastics. Various standards for latex, latex foam, sponge rubber, and adhesives are also included.

ANALOG COMPUTER TECHNIQUES. By C. L. Johnson. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y., 1956. 264 pages, 6 by 9-1/4 inches, bound. $6. It is the purpose of this book to provide students with the information necessary for the competent operation of the electronic differential analyzer, and to demonstrate to engineers the capabilities and limitations of this type of computer. The early chapters discuss linear components, amplitude and time-scale factor adjustment, the setup of linear systems of differential equations, nonlinear components, and function-generating techniques. The later chapters consider such topics as applications to the solution of problems other than ordinary differential equations, checking results, and repetitive analog computers.

APPLIED ELECTRICAL MEASUREMENTS. Edited by I. F. Kinnard. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 600 pages, 5-7/8 by 9-1/4 inches, bound. $15. The two parts of this text and reference book deal, respectively, with the measurement of electrical quantities and the measurement of nonelectrical quantities. Part I includes chapters on the history, theory, and functional analysis of measurements, as well as on methods and mechanisms for the measurement of current and potential difference, resistance, inductance, wave form, etc. Part II covers measurement of light, heat, sound, liquids, gases, and time. The treatment of each subject and method is preceded by a review of the underlying physical and mathmatical principles. There are chapter bibliographies.

THE ART AND SCIENCE OF PROTECTIVE RELAYING. By C. R. Mason. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 410 pages, 5-7/8 by 9-1/4 inches, bound. $12. Elementary in nature, but useful to the practicing engineer as a summary of new advances, this text deals with the fundamental principles of relay design and application. The various types of relays, including wire pilot, carrier-current pilot, and microwave pilot, are treated in detail, and full coverage is given to the protection of the various elements of a power system—generators, motors, transformers, busses, and transmission lines. References are listed at the end of each chapter.

CIRCUIT THEORY AND DESIGN. By J. L. Stewart. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 480 pages, 5-7/8 by 9-1/4 inches, bound. $9.50. This is a descriptive treatment of pole-zero methods and their applications to the synthesis and design of networks both with and without vacuum tubes. The book contains a detailed discussion of the design of low-pass and band-pass amplifiers, and, in three chapters on feedback devices, deals with feedback amplifiers, linear oscillators, and servomechanisms. Intended as a text for undergraduate and graduate students, the level of treatment requires a background in calculus, elementary differential equations, circuit theory, and vacuum tubes.

CONTRACTS, SPECIFICATIONS, AND ENGINEERING RELATIONS. By D. W. Mead. Rewritten by Mead and Hunt, Inc., with J. R. Ackerman. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y., third edition, 1956. 427 pages, 6 by 9-1/4 inches, bound. $7. The first part of this standard text deals with the training and work of the engineer, factors determining professional success, engineering ethics, and the writing of letters and reports. The second part deals, briefly, with the engineer in various legal situations (as an agent, as an expert witness, etc.), and, in more detail, with construction by direct employment and by contract; advertising and letting contracts; and contract documents. The last part of the book covers the preparation of specifications for materials, processes, machinery, and engineering work. Forms, as well as a complete set of specifications for a construction job, are included.

CURRENTS, FIELDS, and PARTICLES. By Francis Bitter. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 599 pages, 6 by 9-1/4 inches, bound. $8.50 The subjects dealt with include electrical quantities, electric fields, electrical properties of matter, magnetic fields, electromagnetism, optics, wave mechanics, atoms and electrons, and atomic nuclei. The book has been written as a text for the second year of a two-year course in physics for science and engineering students.

DAVISON'S TEXTILE BLUE BOOK. Davison Publishing Company, Ridgewood, N. J., 91st edition, 1956. 1,284 pages, 5 by 8-1/4 inches, bound. $7.25 (handy

edition) $9.75 (office edition). This standard guide to the textile industry lists manufacturers of cotton, woolen, worsted, carpet, rayon, silk, and synthetic fabrics, giving principal officers, capitalization, number and types of machines, number of employees, and specialties. It also contains information on knit goods mills, dyers and finishers, associations, schools, etc. The main lists are geographical, with indexes by mills, dyers, and raw cotton firms.

INDUCTION HEATING PRACTICE. By D. Warburton-Brown. Philosophical Library, Inc., 15 E. 40th St., New York, N. Y., 1956. 192 pages, 5-7/8 by 9 inches, bound. $10. The general principles and specific practical applications of induction soldering, brazing, and hardening are discussed, and detailed information is given on the design of coils, inductors, and handling fixtures. Factors to be considered in selecting the process also are treated, and one chapter is devoted to the design of components for production by the induction heating method.

INDUSTRIAL ENGINEERING HANDBOOK. Edited by H. B. Maynard. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., first edition, 1956. Various paging, 6 by 9-1/4 inches, bound. $17.50. This comprehensive reference book for practicing industrial engineers contains 58 chapters grouped in the following 8 sections: the industrial engineering function, methods, work measurements, predetermined elemental time standards, wage payment, control procedures, plant facilities and design, and other aspects. The individual chapters, each prepared by an authority in the field covered, deal with a wide range of techniques and functions, including organizing for industrial engineering; process charts; curves and nomographs; planning and measuring maintenance and construction work; product classification, and the preparation of reports.

INTRODUCTION TO SOLID STATE PHYSICS. By Charles Kittel. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., second edition, 1956. 617 pages, 5-3/4 by 9-1/4 inches, bound. $12. An account of such representative aspects of the physics of solids as crystal structure, thermal and dielectric properties of solids, the free electron and band theories of metals, paramagnetism, ferromagnetism, superconductivity, and semiconductors. This edition provides fuller explanations of basic concepts than did the previous edition and includes new material on alloys, imperfections in solids, photoconductivity, and luminescence. The book is intended for scientists and engineers who may not have had formal courses in the subject, as well as for students of physics, chemistry, and engineering.

KABEL-HERSTELLUNG. By W. Ehlers and H. Lau. Springer-Verlag, Berlin, Germany, 1956. 434 pages, 6-1/4 by 9-3/8 inches, bound. DM 56. This comprehensive treatise on electric cable manufacture first describes the structure and uses of a wide variety of cable types and then discusses the general and specific properties of the insulating materials used. The balance of sections deal with the production methods and equipment for efficient and rapid continuous operation.

MATERIALS OF ENGINEERING. By C. A. Keyser. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1956. 502 pages, 5-5/8 by 8-5/8 inches, bound. $8. Basic information on metals, inorganic nonmetallic materials, and organic materials, presented concisely and with emphasis on practical applications. About three-quarters of the book is devoted to metals, the remainder to such materials as clay, glass, gypsum, concrete, plastics, rubber, organic coatings, and wood.

MECHANICAL DESIGN FOR ELECTRONIC ENGINEERS. By R. H. Garner. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1956. 328 pages, 5-1/2 by 8-3/4 inches, bound. $5. A concise review of methods for the design and construction of rack systems, apparatus cabinets, chassis, panels, and other equipment, along with practical suggestions for sheet metal working, finishing, soldering, brazing, etc. Additional subjects treated include accessibility for servicing, ventilating and cooling, labeling of panels and cables, coil winding, printed circuits and potting of components.

MECHANICAL DESIGN FOR ELECTRONICS PRODUCTION. By J. M. Carroll. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1956. 348 pages, 6 by 9-1/4 inches, bound. $6.50. Intended to meet the needs of electrical and mechanical engineers as well as those of electronics engineers, the book is a compendium of design methods, production processes, and manufacturing techniques used in the electronic industries. The wide range of subjects covered includes space planning, chassis design, fabricating and finishing, shielding, potting, assembly methods, and cabinet construction. A chapter on environmental factors deals with design to withstand shock and vibration, extreme temperatures, explosive atmospheres, and other hazards. The book is based on a group of articles in the October 1954 *Electronics* magazine.

NATIONAL STANDARDS IN A MODERN ECONOMY. Edited by Dickson Reck. Harper and Brothers, 49 E. 33rd St., New York 16, N. Y., 1956. 372 pages, 6-1/8 by 9-1/2 inches, bound. $5. Comprised of a series of articles by well-known authorities, this book is an examination and assessment of the standards movement as a whole within the United States. The articles deal with both the history of the movement and with applications of standards in specific fields: interchangeable parts manufacture, supply and purchasing, telecommunications, agricultural products, military goods, consumer goods, etc. A review of the international standards movement is included, and a number of articles are devoted to the implications of standardization for management, labor, and the consumer.

THE ORIGIN AND NATURE OF ORE DEPOSITS. By R. T. Walker and W. J. Walker. The Walker Associates, Box 1068, Colorado Springs, Col., 1956. 364 pages, 6 by 9-1/4 inches, bound. $6.50. The discussion covers the origin of fissures; mantos; pipes; irregular masses; basic and siliceous ore-bodies; and copper, zinc, lead, silver, gold, and uranium ore-bodies. Several chapters are devoted to the origin of minor metals, and indicator gangue minerals and exploration practice are also treated. The authors give the various theories of origin in condensed form, emphasizing the importance of magmatic gases in mineralization and in certain types of rock alteration.

DER PAPIER-KONDENSATOR. By Hermann Goenningen. Verlag H. Goenningen, Schlitz, Hessen, Germany, second edition. 1956. 215 pages, 5-5/8 by 8-3/8 inches, bound. DM 56. A comprehensive, detailed, and practical treatise on paper capacitors covering fundamentals, design, analyses, manufacture, testing; application problems, and numerical examples of design execution. This new edition has an extensive bibliography of 260 references, mainly German, and lists of German specifications and manufacturers.

PROGRESS IN NUCLEAR ENERGY. Volume 1, Series 2—Reactors. Edited by R. A. Charpie and others. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1956. 492 pages, 6 by 9-1/4 inches, bound. $14. The first five chapters of this review of the present state of reactor technology are summaries of the power reactor programs in the United States, Canada, the United Kingdom, Europe, and the Soviet Union. The remaining six chapters deal with the Shippingport reactor; a prototype boiling water reactor; aqueous homogeneous power reactors; the graphite-moderated, gas-cooled pile; the sodium-cooled graphite reactor; and fast power reactors. A country-by-country list of existing and projected reactors is given at the end of the volume.

PROGRESS IN NUCLEAR ENERGY. Series IV. Technology and Engineering. Volume I. Edited by R. Hurst and S. McLain. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1956. 420 pages, 6-1/4 by 9-1/4 inches, bound. $12. Comprised of selected papers by a number of authorities, this volume reviews the present state of knowledge on coolants, moderators, heat transfer, reactor chemistry, and reactor corrosion. Included are papers dealing with the production of heavy water, graphite, and beryllium oxide; liquid metal handling and pumping; pumps for cooling systems; heat transfer in boiling water systems; and aqueous corrosion of zirconium.

RANDWERTPROBLEME DER MIKROWELLEN-PHYSIK. By F. E. Borgnis and C. H. Papas. Springer-Verlag, Berlin, Germany, 1955. 266 pages, 6-1/8 by 9-1/4 inches, bound. DM 48. A detailed treatment of the handling of boundary value problems in microwave physics. By the use of relatively recent development of mathematical operations it has become possible to gain useful correlation with experimental results. This book uses the static or stationary representation method of Schwinger, basically similar to the "variational principle" method, for approximate analyses leading to a wide range of solutions.

SCIENCE AND ECONOMIC DEVELOPMENT. New Patterns of Living. By R. L. Meier. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 266 pages, 5-7/8 by 9-1/4 inches, bound. $6. The author reviews world needs and resources briefly and discusses possible means of attaining a reasonable level of living for the world's population by the application of recent discoveries in science and technology, particularly in the areas of foods and fuels. He also deals with the possible effects of new technologies on social and industrial organization, and suggests that a "mutant type of scientist and engineer," a scientist-executive, may achieve dominance in the resulting society. Fundamental problems needing solution—the protein supply, low-grade ore utilization, means of transport, and others are listed in an appendix.

A STUDY OF THE THERMAL ASPECTS OF THE LIGHTING SYSTEM. Part I. Its Relation to the Cooling Load. Prepared by a Joint Committee of the ASHAE and the Illuminating Engineering Society (IES). The American Society of Heating and Air-conditioning Engineers (ASHAE), 62 Worth St., New York, N. Y., 1956. 31 pages, 8-1/2 by 11 inches, paper. 75¢. A pamphlet consisting mainly of a series of questions and answers on the relationship between lighting and the factors that enter into the design of cooling systems. Preceding the questions are brief bibliographies on room comfort as affected by radiant energy, lighting and air conditioning, and cooling and heating requirements as related to natural or artificial lighting.

LES TRANSMISSIONS DE PUISSANCE. By Pierre Patin. Editions Eyrolles, Paris, France, 338 pages, 6-1/4 by 9-3/4 inches, bound. Fr. Frs. 3300. A comprehensive treatment of power transmission methods, including speed changing devices. Part I covers theoretical considerations of power transmission, some discussion of strength of materials, and more detailed treatments of the principles of operation of many types of power transmissions for a wide range of uses. Part II gives descriptions of specific devices and machines. Brief treatments are included of bearings, pump units, and servomechanisms.

VACUUM DEPOSITION OF THIN FILMS. By L. Holland. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1956. 541 pages, 5-1/2 by 9 inches, bound. $10. A comprehensive work dealing, in 16 chapters, with deposition procedures and the physical properties of thin films. Material is included on apparatus, plant layout, surface cleaning, techniques for the evaporation of metals and alloys, the preparation of metal oxide films, and the preparation of films for electrical purposes. Also treated are the degassing and coating of plastics, evaporated aluminum films, optical interference films, and cathodic sputtering. There is a bibliography of over 500 references.

WECHSELSTROMMESSTECHNIK. By F. Koppelmann. Springer-Verlag, Berlin, Germany, 1956. 225 pages, 6-1/4 by 9-1/4 inches, bound. DM 30. A general survey of the subject of mechanical rectifiers, particularly the vibrator type, for rectifying low currents (10 to 100 cps), showing the versatility of the instrument. Theory and operation are considered in considerable detail, together with descriptions of designs on the market.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

13 SUGGESTIONS TO HELP YOU . . . GET THE MOST OUT OF INDUSTRIAL TRADE SHOWS. A new edition of this pamphlet is being offered to the public by the Convention Bureau of Standard Printing Service. The pamphlet demonstrates to the visitor of the trade convention or exhibit how he can best utilize his time; what to see and what not to see; and other important information of valuable use to every convention-goer. There is no charge for this literature; merely write to Convention Bureau, Standard Printing Service, 30 N. Dearborn St., Chicago 2, Ill.

A LOW NOISE 215-225 MC CONVERTER. A 215-225 MC Converter to reduce noise in vhf receivers has been designed and developed by the Naval Research Laboratory and is described in a research report available to industry through the Office of Technical Services, U. S. Department of Commerce. The converter achieves a low noise figure in the receiver equipment that was unattainable with previous tubes. With the use of a General Electric (GE) *GL* 6299 triode the converter tunes the desired frequency range while the noise figure remains essentially constant. The improvement in the noise figure is due to low losses, low equivalent noise resistance, and low transit time conductance of the tubes. The GE tube is small in size, has low power requirements, and excellent noise characteristics, according to the report. The converter has also been used in receivers in the 220 Mc region and can be adapted to others in the same frequency range provided that receiver bandwidth need not exceed 1 Mc. The report is PB 121214, L. Hoffman, Naval Research Laboratory, June 1956, 7 pages, price 50¢. It may be ordered from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

SIMPLIFIED PRACTICE RECOMMENDATION *R156-55.* Printed copies of Simplified Practice Recommendation *R156-55*, Steel Outlet Boxes (Zinc or Cadmium Coated), have been made available by the Commodity Standards Division, Office of Technical Services, U. S. Department of Commerce. The recommendation, proposed by the Outlet Box Technical Conference, a group of technical representatives of outlet box manufacturers, covers the types and sizes of formed sheet steel outlet boxes, device boxes, covers, and supports that currently are in general use and demand, and that are regarded as affording an adequate selection for ordinary use. It includes illustrations showing the sizes, dimensions, locations and arrangement of knockouts, as well as other details pertaining to the items covered by the recommendation. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 20¢ each. A discount of 25 per cent will be allowed on orders of 100 or more copies.

RURAL ELECTRIFICATION, VOL. I. A set of 10 papers, describing problems and their possible solutions in various phases of the production, supply, and utilization of electric power in rural areas has been published by the United Nations Economic Commission for Europe (ECE), Geneva, Switzerland, 1956. The papers were written by eight specialists from seven European countries and cover such fields as standardization of tensions used in agricultural plants, utilization of ultraviolet rays in agriculture, and the operation of wind-driven power plants in parallel with low-capacity hydro and thermal plants. The publication is issued as part of a study on rural electrification problems undertaken by the ECE's Committee on Electric Power at the request of the Commission. The purpose of the study is to make available to the less-industrialized countries the results obtained in countries which had given attention to such problems for a long time past and at the same time to give various European countries an opportunity of comparing their experience. 98 pages including many figures and diagrams. May be obtained from the Sales Section, European Office of the United Nations, Geneva, Switzerland, or may be ordered through Sales Agents for United Nations Publications. Price, $5/6 stg., 3.50 Sw.frs. or the equivalent in local currencies.

NATIONAL ELECTRICAL CODE, 1956. The 1956 Edition of the National Electrical Code has been published by the National Fire Protection Association (NFPA), it was announced by C. L. Smith, secretary of the Association's National Electrical Code Committee. The newest edition of the Code is revised from the previous 1953 Edition and contains all interim amendments which have been adopted since publication of the earlier edition. Among the many new features in the 1956 Edition are: tables on current carrying capacity of aluminum conductors, grounding requirements for receptacles used for lawn tools, spacing requirements for receptacles in dwellings, safety provisions for fluorescent lamps, an article on cellular concrete floor raceways, and transformer vault construction recommendations. The National Electrical Code is designed to safeguard persons and buildings from hazards arising from the use of electricity for light, heat, power, radio, signalling, and for other purposes. The Code contains basic minimum provisions considered necessary for safety. The National Electrical Code, 480 pages, is available from the NFPA Publications Department, 60 Battery march St., Boston 10, Mass., at $1 per copy. It also appears in Volume V of the 1956 National Fire Codes published by the NFPA.

NATIONAL FIRE CODES. The National Fire Codes, a compilation of 174 fire safety standards as developed by the National Fire Protection Association (NFPA), have been published by the NFPA in a revised six-volume 1956 edition. The six new volumes by title and content are: Volume I—Flammable Liquids and Gases (35 standards, 860 pages); Volume II—Combustible Solids, Dusts, Chemicals, and Explosives (35 standards, 616 pages); Volume III—Building Construction and Equipment (33 standards, plus an informative discussion of building codes and references to model codes, 704 pages); Volume IV—Extinguishing Equipment (31 standards, 1,024 pages); Volume V—Electrical (The National Electrical Code, new 1956 edition plus six other NFPA electrical standards and a digest of the electrical provisions of 69 other NFPA standards, 704 pages); Volume VI—Transportation and Miscellaneous (25 standards on air, marine, bus, and truck transportation and salvage, plus a comprehensive review of applicable Government regulations, 530 pages). Incorporated in the 1956 volumes are 32 new or revised fire safety standards which were adopted at the 1956 NFPA Annual Meeting. These standards also include all amendments approved by the NFPA Board of Directors up to and including July 30, 1956. The Codes, in keeping with the traditional objectives of the NFPA, are offered as a suggested basis for safety to life and property from fire without causing undue inconvenience and expense. The Codes are purely advisory as far as the National Fire Protection Association is concerned. More than 100 technical committees composed of experts representing the general public, Government, Industry, and insurance prepare and regularly review and revise all NFPA fire safety standards. Many of these standards have subsequently been adopted and published as the official standards of the National Board of Fire Underwriters, the Dominion Board of Insurance Underwriters (Canada), and other organizations. The National Fire Codes, $6 per volume, may be obtained from the Publications Department, National Fire Protection Association, 60 Battermarch St., Boston, Mass.

CHARACTERISTICS OF SOME AIRCRAFT ANTI-COLLISION LIGHTS. Laboratory and flight tests of eight different lighting units to protect aircraft against collision are described in Technical Development Report No. *284* released by the Civil Aeronautics Administration (CAA). Lighting units installed on a *DC-3* airplane were tested in flights on clear nights and at altitudes above any existing haze. Various angles of approach were flown so that all of the light units were observed from all significant angles. The units were mounted and located on the plane to permit easy installation and flight observation and not from the standpoint of economy, maintenance, or effectiveness. The report includes photographs of all lighting units, tables on lamp data, lamp characteristics, transmission characteristics of lighting-unit covers or filters, summary of flight-unit characteristics, and flight test data. For purposes of comparison, the characteristics of the conventional low-intensity position lights were measured and are also reported. The report, *PB 121329*, C. B. Phillips and A. L. Morse, CAA Technical Development Center, June 1956, may be ordered from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. It contains 27 pages, price 75¢.

POWER AND GAS TUBES. The revised edition of this RCA booklet contains technical data on 175 types of tubes including vacuum power tubes—air-cooled, forced-air-cooled, and water-cooled—ranging in power-output capability up to 100 kw; rectifier tubes—vacuum, mercury-vapor, and gas; thyratrons—gas and mercury-vapor; ignitrons; magnetrons, and vacuum-gauge tubes. Each tube type is accompanied with a brief general description, charted dimensions, ratings and operating values, and a base or terminal-connection diagram. Photographs of representative tube types in each tube family are shown throughout the publication. The 24-page booklet (*PG181C*) may be obtained at Radio Corporation of America Tube Distributors or by sending 20¢ to Commercial Engineering, RCA Tube Division, Harrison, N. J.

RESEARCH IS PEOPLE. This brochure contains a group of papers which were presented at the 51st meeting of the Industrial Research Institute, April 1956. The papers, which revolve around the central subject of the research scientist and engineer, are divided into three topics: Recruitment Today, Motivation of a Research Man, and Rating and Evaluation of Personnel. They are preceded by a portion of the remarks made by Dr. Victor Conquest upon the presentation to him of the Institute's annual Medal Award for outstanding accomplishment in leadership in management of industrial research. 69 pages, for sale through New York University Press, Washington Square, New York 3, N. Y. Make check ($4 per copy) payable to New York University Press.

CALCULATING COEFFICIENTS OF UTILIZATION. An entirely new, simplified, and more accurate method for making lighting calculations for interiors has been introduced by the Illuminating Engineering Society (IES) Committee on Lighting Design Practice in this report. The new method is a departure from the "Lumen Method" adopted in 1920 in that ceilings of over 80 per cent reflectance (rather than the then average of 75 per cent) are now common. Use of the figure will lessen the effect of resulting calculated coefficients of utilization being unnecessarily conservative when the ceiling is white. This higher ceiling reflectance also increases the reflectance from floor surfaces. Technicians now computing coefficients of utilization thus attain more accurate figures with the new method. The report, in addition to explaining the basic method, includes complete work sheets with step-by-step instructions for their use, and numerous charts showing a variety of room ratios based on reflectances and type of luminaire. Copies of this report are 50¢ each. Complete sets of work sheets also are available separately at 5¢ each. White Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. Quantity prices on request.

MECHANICAL DESIGN FOR ELECTRONICS PRODUCTION. By J. M. Carroll, associate editor, *Electronics*. 360 pages, illustrated. McGraw-Hill. $6.50. This is a new design aid which gives a good deal of information on the special problems of manufacturing devices using electron tubes and transistors. The treatment follows the steps of the designer who must translate an aggregation of electronic breadboard circuits to an item of finished equipment sufficiently rugged to withstand its intended environment and able to be manufactured for the lowest possible cost. Information on a wide variety of processes and materials is given, including mechanical layout of equipment, sheet-metal work, machining operations, electric and magnetic shielding, use of resins and other sealing compounds, and mechanisms and electric motors. Other helpful related subjects are covered, such as mechanized assembly, modular design and efficient equipment packaging, and nonelectrical acceptance tests required for Government equipment. The book includes facts and data on such subjects as the USAF cylindrical housings for electronic equipment; special plastic compounds both for making parts and for sealing; instrument-type servomechanisms; techniques of etched wiring and dip soldering; design of equipment to withstand vibration, shock, high temperatures and humidity; and application of human engineering factors to design of control panels, etc. The book is based on a series of articles on this subject that appeared in *Electronics*. In the selection and editing of material, an effort was made to present the information needed by electrical and mechanical engineers as well as by electronic engineers. Further details are available from McGraw-Hill's Book Information Service, 327 W. 41st St., New York 36, N. Y.

SYMPOSIUM ON IMPACT TESTING. ASTM Special Technical Publication No. *176*. In the past few years engineers and technologists have had increasing interest in the effect of impact and shock on various materials. Both on a theoretical and practical basis, investigations have pushed forward new thinking about impact testing not confined to notch bar testing. This symposium, sponsored by Committee E-1 on Methods of Testing, tries to fulfill the larger needs of this area of testing by including papers discussing impact and shock tests for parts, components, and complete structures. Five additional papers considered timely and appropriate to the subject are included along with the material presented through the symposium. Such latest innovations as the impact tube are discussed and environmental conditions, particularly temperature, are considered. The broad outlook is taken, so as to enhance the practical application of this type of work. The book which contains many graphs, charts, and photographs, also contains several bibliographies. 172 pages. Copies may be obtained from the American Society for Testing Materials, 1816 Race St., Philadelphia, Pa., for $3.50 each.

PROCEEDINGS OF THE CONFERENCE ON RADIO INTERFERENCE REDUCTION, VOL. I AND II. These books comprise the complete text of papers presented at the 1954 and 1956 Conferences and cover both tutorial aspects and contemporary developments in the field of electronic and electrical interference reduction. The papers cover material of interest to both manufacturers and research and development laboratories, including the areas of measurements, design techniques, practical suppression measures, and component development. Equipment and systems covered encompass radio and radar, aircraft and missiles, vehicles, and electronic devices. These volumes are available at a cost of $5 for the set, and may be obtained from Armour Research Foundation, Department E, 10 W. 35th St., Chicago 16, Ill.

RECEIVING TUBE MANUAL. A new edition of the RCA Receiving Tube Manual, revised, presents data on more than 650 receiving and picture tubes. The manual (*RC-18*) was expanded and brought up to date by the RCA Tube Division in Harrison, N. J. It contains technical data on more than 575 receiving tubes, including types for black-and-white and color television, as well as series-string applications. In addition to these more than 75 picture tubes, including color types, are treated. The manual covers basic tube theory and application information in the easily understood style of its predecessor. The section on electron tube applications includes a description of television applications such as tuner circuits, video amplifiers, sync circuits, automatic-gain-control circuits, and deflection systems. Other sections include information on generic tube types, interpretation of tube data, and electron tube installation. A classification chart for receiving tubes is arranged to facilitate rapid selection of RCA types according to their family class, functions, and filament or heater voltages. Technical data on picture tubes are tabulated in a characteristics chart to permit quick comparison of the features of individual types. Diagrams on which to base problems are given on accompanying pages for ease of reference. The section on circuits covers such typical applications as superheterodyne, superregenerative, and shortwave receiver

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INDUSTRIAL NOTES

Line Expanded, Name Change. Sel-Rex Precious Metals, Inc., has expanded its product line to include electroplating processes and chemicals, other than precious metals, as well as electroplating equipment of their own design and manufacture. The corporate name has been changed to Sel-Rex Corporation, with executive offices at 155 Manchester Place, Newark 4, N. J., in order to avoid the misleading impression that the firm deals exclusively in precious metals.

Special Engineering Products Division. International Business Machines Corporation (IBM) has announced the formation of a Special Engineering Products Division. J. A. Haddad, director of advance machine development, who was in charge of the design and construction of the IBM *701* electronic data processing machine, first of the company's famous *700* line of giant computers, has been named general manager. K. N. Davis, Jr., has been named controller of the new division. The diversified activity of the new division will include design, development, and manufacture of nonstandard computing and data handling components, machines, and systems; and modification of standard IBM or other equipment to meet special commercial and scientific data processing requirements.

Alumina from Clay. The Anaconda Company, Anaconda, Mont., announced that after nearly two years of laboratory and test plant work it has solved the problem of producing alumina from clay located in the area of Moscow, Idaho. Company spokesmen stated that the alumina thus produced has been in substantial quantities and within the specifications required by it under its contracts for this material extracted from bauxite. Alumina is the substance from which aluminum is made. Heretofore, it has been extracted from bauxite, of which the principal sources of supply for the United States are the islands of the Caribbean. It has been known that alumina also is contained in commercial quantities in some of the clays of the United States. Attempts had been made, without success by the United States Bureau of Mines and other agencies for more than 25 years, to solve the problem of extracting alumina from these domestic clays. It was not until May 1956 that a test plant, constructed by Anaconda, Mont., finally succeeded in producing a commercial grade of alumina. Now, the company is in the process of designing and constructing a pilot plant of 50-tons-per-day capacity, from which it is expected a full-scale commercial plant will be developed with adequate capacity to furnish the company's total requirements for alumina on an economically competitive basis.

Reynolds Expands. A new addition to Reynolds Metals Company's aluminum wire and cable mill, in Sheffield, Ala., for production of neoprene and polyethylene covered and insulated electrical conductors, is nearing completion. The facilities are housed in a new building, bringing total floor space of the overall cable operation to 174,000 square feet. New equipment for applying thermosetting and thermoplastic coverings will be used initially for neoprene and polyethylene insulation. Equipment for fabricating selfsupporting aerial secondary cables also has been installed. Complete equipment necessary for quality testing has been added. The tests include those for dielectric strength after water immersion, tensile and elongation tests before and after oil immersion, as well as oxygen bomb and air oven tests. Facilities also are provided for refrigerated storage of perishable materials such as neoprene and rubber compounds.

Automatic Resistor-Production Equipment. This line has been developed especially for metal-film and carbon-deposited precision resistors by Industrial Instruments, Inc., Cedar Grove, N. J. The latest version of basic sorting equipment segregates the resistors after coating. With an accuracy of better than ± 0.5 percent, the equipment is fully automatic and sorts resistors without leads into eight resistance categories at a speed of 3,600 pieces per hour. The unit is also available for handling components with leads attached. An automatic spiraling lathe is the second unit. Magazine-fed and electronically controlled, it stops its spiraling function when a preset resistance value is attained. This unit is also available for spiraling resistors with or without leads attached. The third unit is a high-speed, extremely accurate d-c limit bridge for final testing of completed resistors. Accurate to better than ± 0.1 percent over the range of from 100 ohms to 10 megohms, the equipment is applicable, with the same accuracy, to lower values when setup arrangements have been made to balance out zero resistance in bridge and contact circuits. Operating speed is 5,000 pieces per hour, and the equipment is supplied with semiautomatic feeder and storage facilities to enable one operator to attend a number of machines. Specifications, price, and delivery information is available on all models from the company.

New Office Building. The SoundScriber Corporation, 146 Munson St., New Haven, Conn., manufacturers of electronic dictating and transcribing equipment, and magnetic tape recorders, has announced completion of plans for the construction of a 55,000 square-foot office building and manufacturing plant in North Haven, Conn. Construction of the modern, single-story brick and masonry block building has begun with occupancy scheduled for April 1, 1957.

(Continued on page 42A)

Spaulding Gives PROMPT, PERSONAL ATTENTION to your problems

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44 Washington St.
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Camden 1, N. J., 227 South Sixth St.
Chicago 25, Ill., 4770 Lincoln Ave.
Chicago 38, Ill., 5604 West 63rd St.
Cleveland 14, Ohio, 2108 Payne Ave.
Cleveland 16, Ohio, 19035 Detroit Rd.,
Rocky River
Dayton 2, Ohio, 136 So. Ludlow St.
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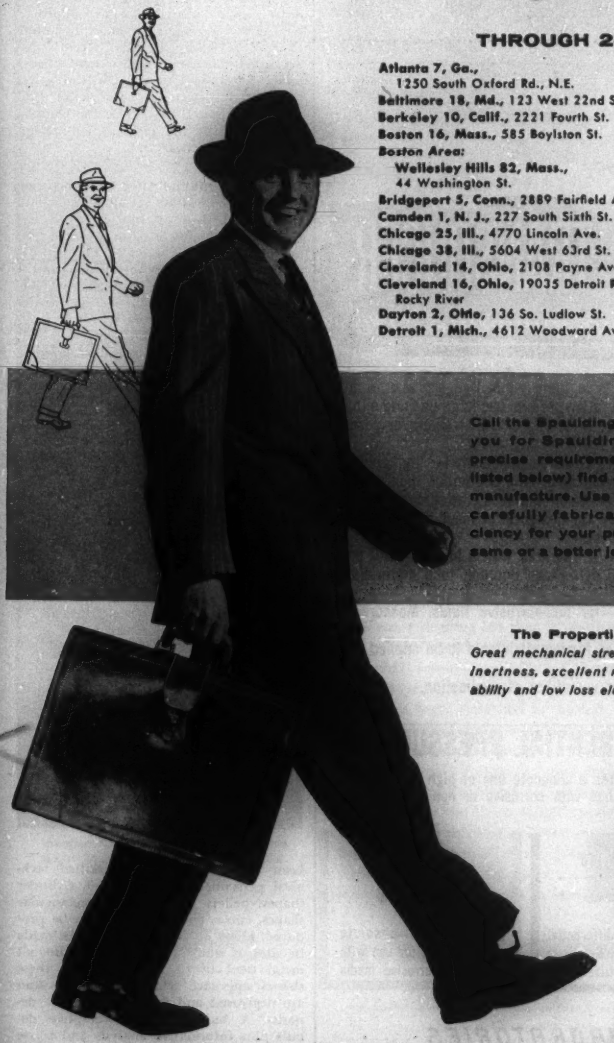
Woodhaven 21
Los Angeles 15, Calif.,
1325 San Julian St.
Milwaukee 8, Wisc., 3329 West Vliet St.
New York 55, N. Y., 384 East 149th St.
St. Louis 5, Mo., 7247 Olive Street Road
St. Louis 17, Mo., 1500 Big Bend Blvd.
Tonawanda, N. Y., 310 Wheeler St.
Westfield, N. J. (Newark Area),
101 Central Ave.
Toronto 14, Ont.,
A. A. Andersen & Co., Ltd.,
20 Algie Ave.



Call the Spaulding man at the Branch Office nearest you for Spaulding materials fabricated to your precise requirements. Spaulding products (listed below) find application in almost every field of manufacture. Use these versatile materials and parts carefully fabricated in our plant, for greater efficiency for your products without extra cost, or the same or a better job at lower cost.

The Properties of Spaulding Materials Include
Great mechanical strength, extremely light weight, durability, chemical inertness, excellent machining qualities, arc resistance, deionizing ability and low loss electrical insulation.

WE MAKE AND FABRICATE

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.
ARMITE: Thin Insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.
SPAULDITE: (Laminated Thermosetting Plastic) in sheets, rods, tubes and fabricated parts.
SPAULDO: Motor Insulation in sheets, rolls, coil, slot cells and other fabricated parts.
SPAULDING FIBRE BOARD: In sheets and fabricated parts.
SPAULDING T BOARD: A superior Transformer Board in sheets and fabricated parts.
MATERIALS-HANDLING EQUIPMENT: Factory Trucks Boxes, Barrels, Trays, etc.
SPAULDING FABRICATING FACILITIES: Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation.

Spaulding Fibre Company, Inc., 310 Wheeler Street, Tonawanda, N.Y.

MODEL 304

GAGE PRESSURE TRANSDUCER

—high performance in miniature size

Only 1⅛" in diameter... ¾" thick, this is an exceptionally small gage pressure potentiometer. Its miniature size and compact configuration permits use in ground and airborne installations—in control telemetering or remote recording circuits—wherever space is at a premium.

Time proved performance. This is a fully integrated instrument built for high reliability under extreme environmental conditions. The dependable Bourns Bourdon tube assembly and linkage system provide exceptional shock, vibration and acceleration characteristics ... linearity and hysteresis are excellent. Units are designed to meet or exceed most government specifications for airborne equipment.

The Bourns Model 304 weighs about 2 ounces. It operates with a high-level AC or DC signal. Pressure ranges: from 0-100 to 0-5000 psi. Three Bourdon tube materials are available:

Beryllium copper—the standard construction—for non-corrosive fluids. Measures air, Freon, oil, and other common media.

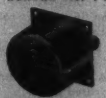
Stainless steel—permits corrosive fluids such as fuming nitric acid to be applied within the tube.

Ni-Span-C—provides low temperature error for versatility of application.

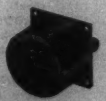
Complete data in Bulletin No. 304.

ABSOLUTE AND DIFFERENTIAL PRESSURE

In addition to the Model 304, Bourns manufactures a complete line of high pressure transducers in absolute and differential ranges, for use with corrosive or non-corrosive fluids. Request Bulletin No. 70456.



MODEL 704—differential pressure type with stainless steel Bourdon tube



MODEL 706—differential pressure type with Beryllium copper Bourdon tube

MODEL 705—absolute pressure type for use with clean, non-corrosive media

COPR. BL

BOURNS LABORATORIES

General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

(Continued from page 34A)

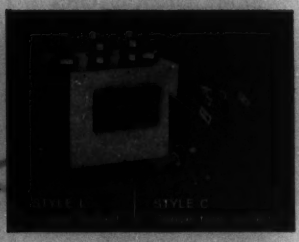
Industrial Notes

Name Change. The name of the Burndy Engineering Co., Inc., has been changed to Burndy Corporation. The manufacturer of electrical connectors and installation tooling, Burndy has headquarters in Norwalk, Conn., and plants and warehouses in New York, N. Y.; Milford, North Haven, and Stamford, Conn.; Chicago, Ill.; Lynwood, Calif.; and Toronto, Ont., Canada. The change in name to Burndy Corporation reflects the broadening of the organization's activities. For improved service to customers in several rapidly expanding fields, Burndy recently reorganized its activities into two autonomous divisions. The U-I Division serves utilities and electrical construction and maintenance activities, while the Omaton Division serves the original equipment, aircraft, and military markets.

Doping Element and Alloy Manufacturing Facilities. Full scale production of all shapes and sizes of the elements and their alloys found in groups three and five of the periodic chart is now in progress by the high purity metals department of Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. These high purity metals, vital to the manufacture of semiconductors, are used as doping agents in the original germanium or silicon growing process and also in diffusion type n-p-n or p-n-p crystals. The latest equipment for alloying, rolling, and punching has

been acquired and highly skilled technical personnel has been hired. Cylinder shapes, pellets, 3-dimensional rectangular shapes, cubes, and spheres are to be produced. Many of these shapes can be made in sizes as small as 0.010 inch. Also, all metal used in the production of these shapes approach 99.99+ in purity and are degreased and free from organic deposits. A bulletin giving complete details plus informative analysis and phase diagram charts is available.

(Continued on page 44A)



International offers a complete line of Germanium Power Rectifiers. For complete details on all types, request Bulletin GPR-1.

Finned copper housings—the most efficient heat exchangers yet adapted to power rectifiers—measuring less than 2" in diameter, provide a total cooling surface of 58.3 sq. inches! International's Style F Germanium Power Rectifier utilizes this junction, which has been acclaimed by leaders in the engineering profession as the most advanced rectifier design in the industry.

International's Research Laboratories and Production Facilities have produced a line of Germanium Power Rectifiers offering unexcelled performance. Four years of field testing indicate efficiency up to 97%, with unlimited life expectancy. 12,000-hour tests show no change in forward or reverse resistance. Extremely low leakage current and low forward drop (lowest of all available metallic rectifiers) emphasize the advantages of these units. D.C. output current ranges up to 2250 amps per assembly, and up to 100,000 amps in combination. The input voltage ranges up to 66 volts rms per junction, with an operation temperature range from −55° C to +75° C.

The far-reaching research and development program of International assures you of greater rectification efficiency and reliability. A wire, letter or phone call to Application Advisory Department will bring an immediate and experienced recommendation for your application.

A WORLD OF DIFFERENCE ...THROUGH RESEARCH

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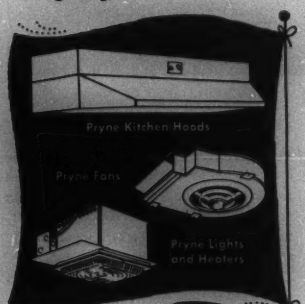
Great new designs —'sales-engineered' for volume sales! Produced by skilled craftsmen...backed with 33 years of manufacturing 'know-how'!



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P.O. Box 698, Pomona, California
Okay—please keep me posted on Pryne.

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Company

Address

City Zone State

(Continued from page 42A)

NEW PRODUCTS

Torque-Brake Units. Three of these units giving a wide range of speed-torque characteristics have been developed by the B. A. Wesche Electric Company, 1622 Vine St., Cincinnati 10, Ohio. Designed to provide continuous tension, these motors are especially applicable to wire winding. Torque can be decreased by reducing the applied voltage or increased if intermittent ratings are permissible in the application. The company can supply units which provide other speed torque characteristics to meet specific applications.

Compression Fitting Tools. Tools for compression fittings feature interchangeable insert dies that snap in and out with two-finger ease. The lever-action tools are said to install the widest range of compression sleeves and fittings, with greatly increased operating efficiency. Each self-aligning die half locks into its rectangular seat by a shoulder and a groove, and is held in place by spring-locking pins. This prevents any possibility of the dies "rocking" or "canting," and gives utmost rigidity for operation of the tools. Dies are available from the manufacturer to install compression fittings for most wire sizes used on distributing systems. The manufacturer states these new tools are lightweight, rugged, and economical in cost, and safe for use on energized circuits at distribution voltages. For further information, write James R. Kearney Corporation, 4224-42 Clayton Ave., St. Louis 10, Mo., and request free bulletin No. *13*.

Fluorescent Luminaire. Now completed is a full line of fluorescent street lighting luminaires by the General Electric Company, Schenectady 5, N. Y. A 4-lamp, 6-foot luminaire has been completely redesigned from the form *406* unit and is available with a number of new features. The luminaire, now designated the form *406S*, produces 21,200 lumens and is designed for use on main streets, bridges, and other heavily-traveled areas. It features a new slipfitter mounting which, combined with the leveling cradle support and three cup-pointed set screws, provides ease of installation and secure mounting. It also makes possible placement of the luminaire over the roadway for improved visibility and easier maintenance. The durable, weathertight, one-piece globe of clear acrylic plastic is side-hinged for convenient relamping and maintenance; wiring has been simplfied by use of a terminal board; springloaded sockets now provide a simple and secure means of installing recessed, double-contact base lamps; resilient gasket material has been combined with latch hinges to form a secure seal with the aluminum hood; body construction is stronger and more rugged; and a spring-loaded hinge on the reflector assembly provides a firm mounting and access to the terminal board, leveling cradle, and ballasts.

(Continued on page 48A)

NORTHWEST INDUSTRIES LIMITED

Edmonton, Alberta, Canada is engaged in the conversion, repair, and overhaul of airframes and aircraft instruments for the Royal Canadian Air Force and for civilian operators. At the present time, the Company is working on the following types of aircraft—Douglas DC3's, C47's, and C54's; North American T6 Harvard Trainers; Fairchild C119 Packets; Canadair-built T33 Jet Trainers; De Haviland Beavers, Otters and Doves; and Curtis C46's. About 800 men are employed in above work.

Vacancies are presently open for a SENIOR ELECTRONICS ENGINEER to supervise the work of a small group of electrical engineers and draftsmen engaged on electronic installation work in aircraft. A degree in electrical engineering is essential and several years experience in airborne equipment and installations, including ground and flight tests is required. Salary range is $7800-$8700 per year.

ELECTRONICS PROJECT ENGINEER to assist above noted Senior Electronic Engineer. A degree in electrical engineering or its equivalent and not less than three years experience in design of electronic installations in aircraft. Salary range $6300-$6900 per year.

Generous Employee Benefits are available with the Company sharing the cost. Edmonton is Canada's 6th largest city with a population of 250,000 and living accommodation is good.

If qualified, send resumes to Industrial Relations Manager, Northwest Industries Limited, Municipal Airport, Edmonton, Alberta, Canada.

SYMPOSIUM on ELECTRICAL PROPERTIES of SEMICONDUCTORS and the TRANSISTOR

A series of four articles, compilations of papers originally presented at a symposium on electrical properties of semiconductors and the transistor, held during the AIEE Summer General Meeting, Swampscott, Mass., June 1949. Sponsored by the Subcommittee on Electrical Properties of Solids and Liquids of the AIEE Committee on Basic Sciences.

It is hoped that this pamphlet (S-36, January 1950) will prove useful not only to the practicing engineer and teacher, but also to engineering students as an introduction to this field of electrical engineering.

Price is $0.50 ($0.25 to AIEE members). Send orders to: Order Department, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, 33 West 39th Street, New York 18, N.Y.

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Omega West, newest of the research reactors at Omega site in Los Alamos, is one of several reactors in operation or under development at the Laboratory. The OWR is designed for high flux at low cost, flexible operation, and has extremely versatile port facilities. This installation is an important addition to the impressive array of research facilities available to Los Alamos scientists.

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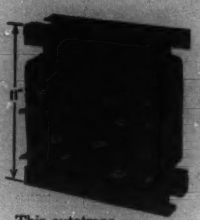
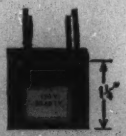
THE RIGHT SPECIALTY TRANSFORMER

This is just a small sample of the broad line of specialty transformers built by Hevi Duty Electric Company. They are available in all sizes with any desired primary or secondary voltages or frequencies. All are designed to meet or exceed NEMA standards.

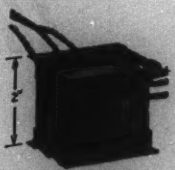


This autotransformer is used for reduced-voltage starting of synchronous and induction motors. 50, 65 and 80 percent taps are normally provided. Terminals may be mounted on the coil or leads.



Low-voltage pilot light transformers up to 600 V primary.

Type SICB, 150 VA, 230/460-115 volts, enclosed style with a built-in thermal circuit breaker for overload protection. This compact unit saves valuable panel space.



Type SIO, 10 VA, primary 110/220 volts
CONTROL WINDING — Secondary 230 volts, .032 amps, 7.4 VA
FILAMENT WINDING — Secondary 6.3 volts, .3 amps, 1.9 VA

Write for bulletins HD-499 and T-5111 or send us your requirements.

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HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
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IN

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OPERATIONAL ANALYSIS
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Design, development, testing, and operation of nuclear reactors and component parts for research, production, power, and aircraft propulsion.

Design and development of pilot and production plants and processes in the over-all atomic energy programs.

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(Continued from page 44A)

New Products

Tape Dispenser. A series of four fully automatic air-operated tape dispensers for the electrical and electronic industries has been announced by Air Fixtures, Inc., 202 W. Main St., North Manchester, Ind. All push buttons, levers, and foot pedals are eliminated. When the operator removes a length of tape, a microswitch automatically sets in motion the next delivery cycle. It is available for all types of pressure-sensitive tape in widths up to 4 inches and lengths up to 21 inches. For further information, write to the company.

Shuttle Valve. Two models of a shuttle valve have been introduced by the Ross Operating Valve Company, Detroit 1, Mich. Offered in ¼-inch and ⅜-inch pipe sizes, the shuttle valve has envelope dimensions of 1¼ inches and 2¾ inches long. With two inlets and one outlet, the brass unit can be used either for air or for certain types of liquids. Weighing only 14 ounces, this new valve has a differential sealing pressure of 15 pounds per square inch (psi) and operating pressure of 15 to 125 psi. The temperature range is up to 175 F.

Ventilation on Magnetic Slip Couplings. First units of a new magnetic drive using a cross-flow ventilation system have been completed and tested. The new concept in air cooling and important mechanical design changes accounts for significant savings in space required, compared to previous designs. Over-all simplification of the design minimizes maintenance. This magnetic drive, called type *MDS* by the manufacturer, Electric Machinery Mfg. Company, Minneapolis 13, Minn., takes the place of two existing lines, the *MDC* and *MBE* types. A single basic design now is used for all sizes and ratings from 200 hp at 720 rpm to over 2,500 hp at higher speeds. Major components of the magnetic drive are a ring member, coupled or belted to a driving motor, and a magnet member, similar to the rotor of a synchronous motor, and connected to the load. Magnetic reaction between the two rotors, hence, the speed of the magnet member, is controlled by the amount of direct current fed to the field poles from magnetic amplifier control called the "Regutron." Information on rating, bearings, and construction is given in publication *4400-PRD-232* obtainable from the company.

Electric Rotary Hammer. A portable electric rotary hammer, which uses shock waves to drill faster than ever thought possible, has been developed. Creating over 36,000 shock waves a minute, it cuts a clean, true hole up to 40 feet in depth through the hardest stone, rock, or reinforced concrete. It weighs approximately 10 pounds and requires no pressure. Difficult overhead or horizontal work can be handled with remarkable ease. For further information write: Demo-Haines Tool Corporation, North 10th Machine Works, Enid, Okla.

(Continued on page 53A)

(Continued on page 48A)

New Products

Switches. Two new types of interlocking push button switches, mounted in parallel row assemblies to provide a maximum number of interlocked stations, have been introduced by Donald P. Mossman, Inc., Brewster, N.Y. The series *5900* is available with up to 36 interlocking stations, and the series *5700* with a maximum of 24 stations. Each station may be equipped with various contact combinations, rated 3 or 5 amperes, 110 volts a-c (noninductive). Normal operation provides that each button depressed releases any previously operated station, and itself locks in the operated position. Additional construction features available include a lock-out to prevent operation of more than one station at a time, solenoid release, and nonlocking stations. The series *5900* may be had with individually illuminated buttons, and the series *5700* is available with accumulative lock-in construction.

Microfilm Reader that Prints. A reader, which will also make large prints simply by direct projection of the film image onto photocopying paper, has been announced by the Filmsort Division of Dexter Folder Co., Pearl River, N. Y. Known as The Examiner, the new unit will be the largest of the desk-top models in the company's line of readers and printers. In addition to its general applications of uses as a viewer and printer with aperture cards (the filmsort system of mounting

individual frames of microfilm in standard file cards or punched cards) or jacket cards (strips of microfilm housed in acetate or paper jackets), there are a number of special uses. The viewing and printing screen makes this unit suitable for legal, banking, title search, and general business operations in which enlargement copies are an important factor.

(Continued on page 65A)

To the *creative* engineer...

AiResearch two stage lightweight gas turbine compressor provides pneumatic power for aircraft main engine starting and serves as auxiliary power source for a variety of ground and in-flight services.

The rapid scientific advance of our modern civilization is the result of new ideas from creative minds that are focused on the future. Our engineers not only have ideas but have the ability to engineer them into products.

That's why The Garrett Corporation has grown in both size and reputation to leadership in its areas of operation. That's why we are seeking more creative engineers to help us maintain and extend our leadership. If you fall in that category, you'll find working with us fulfilling in stimulation, achievement and financial rewards.

All modern U.S. and many foreign aircraft are Garrett equipped. We have pioneered such fields as refrigeration systems, pneumatic valves and controls, temperature controls, cabin air compressors, turbine motors, gas turbine engines, cabin pressure controls, heat transfer equipment, electro-mechanical equipment, electronic computers and controls.

We are seeking engineers in all categories to help us advance our knowledge in these and other fields. Send resume of your education and experience today to: Mr. G. D. Bradley

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A NEW IDEA IN POWER DISTRIBUTION

WESTINGHOUSE

UNI-BUS

From Westinghouse comes a new busway—a method of distributing power—so new, so much better, it makes conventional methods seem old fashioned. Uni-bus!

For the first time, it combines the advantages of plug-in duct with a low-impedance system.

And Uni-bus has a new idea in installation . . . the flexible connector. This one unit does away with all special fittings—simplifies time-consuming field measuring. This feature combines with special clip-on hangers to effect time savings during installation.

Uni-bus is the only completely safe busway because it is impossible for anyone to touch live parts through plug-in openings. Added protection is provided by the unique plug-in devices and triple-wrapped insulation on bus bars.

The features making these benefits possible are shown at right. Call your Westinghouse distributor today. Or write for booklet, B-7015, Westinghouse Electric Corporation, 3 Gateway Center, Pittsburgh 30, Pa. J-30239

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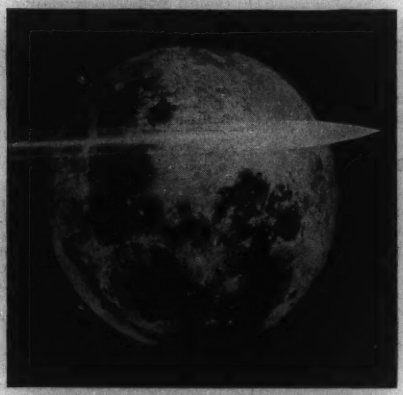
Engineers who will accept the challenge of the most urgent program in the free world today...

Long Range Guided Missiles



Ten years ago there was only a handful of men in the country who said it could be done. Today, more and more engineers—their technological noses scenting the fact that engineering history is in the making—are picking up the gauntlet of the greatest engineering challenge American ingenuity has ever faced—the race against time and the phenomena of long range guided missiles.

Dr. E. R. van DRIEST, Chief Scientist, is nationally recognized for his work in aerothermodynamics. He has a BS, Case Institute of Technology; MS, University of Iowa; Ph.D., Cal Tech; and Sc.D, Technisch Hochschule, Zurich, Switzerland. Around his home, in Whittier, he finds ideal opportunities for the pursuits he and his family like best—horseback-riding, archery and other outdoor activities—perfect complement to the absorbing mysteries of his work.

Research and development that would ordinarily take years is today—of necessity—being telescoped into months. Problems of aerodynamics, thermodynamics, high temperature materials, aeroelasticity—that a decade ago were only theory in textbooks are today being solved. What's more, the production techniques necessary to turn these solutions into hardware have been evolved.

Major Missile Center

One of the major centers of this activity is North American Aviation's Missile Development Division. In 1945 North American started a program of research and development in this field. As far back as 1948, the first NATIV—North American Test Instrument Vehicle—streaked to trajectory altitude of 10 miles. One result of this type of pioneering was complete weapons system responsibility for the Air Force SM-64 Navaho Intercontinental Guided Missile—a gigantic task embracing almost every field of engineering.

JIM THOMPSON's career in missile engineering at North American began in 1951. Today, Jim is Group Leader of Flight Instrumentation at the Missile Test Facility, Patrick Air Force Base, Florida. The tropical climate there is ideal for his favorite sports—fishing and golf.

Progress Grows Apace

We can't give details here, or describe facilities, solutions, flight tests. But we *can* tell you this: a new engineering chapter is being written. It is reaching its climactic phase. There will never be a better time for you to become a Missile Engineer.

Are You This Kind of Man?

Can you break with tradition... leave conventional methods behind... and explore the unknown with the faith that in every obstacle lies the seeds of new successes?

MANUEL C. SANZ, Chief of Materials Research, found unique scope for his special talents at North American. This Chemical Engineer, with a Masters in Physics and Chemistry, is named as the inventor in a patent on the famous Chem-Mill Process. His son leads a Los Angeles school band—with a chem-milled baton!

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a management climate which stimulates personal growth—and rewards it with responsibility, professional recognition and material benefits limited only by your own abilities. Your own academic stature can be constantly enlarged with our Educational Refund Plan—and some of the nation's finest universities are close at hand.

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Contact: Mr. M. Brunetti, Engineering Personnel Dept. 911EE
Missile Development Division, 12214 Lakewood Blvd., Downey, California.

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- H Carrier Line Filter and Balancing Panel (X66217C)

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- 40C1 Carrier-Telegraph Channel Terminal (J70047C)
- 140A1 Carrier Supply (J70036A1, etc.)
- 40AC1 Carrier-Telegraph Terminal
- Grid Emission Test Set (J70047D1)

VOICE-FREQUENCY EQUIPMENT
- V1 Telephone Repeater (J68368F)
- Power Supply (J68638A1)
- V1 Amplifiers (J68635E2 and J68635A2)
- V3 Amplifier (J68649A)
- V-F Ringers (J68602, etc.)
- Four Wire Terminating Set (J68625G1)
- 1C Volume Limiter (J68736C)

D-C TELEGRAPH EQUIPMENT
- 16B1 Telegraph Repeater (J70037B)
- 10E1 Telegraph Repeater (J70021A)
- 128B2 Teletypewriter Subscriber Set (J70027A)
- Composite Sets, several types

TEST EQUIPMENT
- 2A Toll Test Unit (X63699A)
- 12B, 13A, 30A (J64030A), and 32A (J64032A) Transmission Measuring Sets
- 111A2 Relay Test Panel (J66118E)
- 118C2 Telegraph Transmission Measuring Set (J70069K)
- 163A2 Test Unit (J70045D)
- 163C1 Test Unit (J70045D)

COMPONENTS AND ACCESSORIES
- 255A and 209FG Polar Relays
- Repeating Coils, several types
- Retard Coils, several types
- 184, 185, 230A and 230B Jack Mountings

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102D, F and L	328A	398A
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(Continued from page 53A)

New Products

Power Resistor. A flexible power resistor, specially developed for printed circuits, has been announced by Lectrohm, Inc. The light weight and flexibility of these resistors offer the advantages of easy assembly and simplicity of making changes in resistance and voltage without changing the holes in the mounting board. The element is wound on a flexible fiberglass core. The sleeving, also of fiberglass, is heavily saturated with silicone to pass requirements for above chassis mounting. Tapered semitubular terminals have been designed particularly for soldering in printed circuit boards. They eliminate popping-out problems experienced with solid type terminals. Five-watt resistors in values up to 2,500 ohms and 10-watt resistors up to 5,000 ohms are in production. For complete details, write to Lectrohm, Inc., 5560 Northwest Highway, Chicago 30, Ill.

Pagemaster. Members of the staff of Strong Memorial Hospital, Rochester, N.Y., are paged quietly and individually through a new "Pagemaster" selective paging system manufactured by Stromberg-Carlson, a Division of General Dynamics Corporation, Rochester 3, N.Y. With this system, the individual doctor or other staff member carries a small radio receiver in his pocket. This unit is about the size of a package of cigarettes. The receiver is tuned to respond only to a certain coded signal. When that signal is received, the device emits a clear buzzing sound, which informs the person carrying that particular receiver that he is being paged. He then steps to the nearest telephone, identifies himself to the operator, and receives the message. The paging signals are broadcast from a small radio transmitter, with its control panel, or "encoder," located at the hospital's telephone switchboard within easy reach of one of the operators. When she wants to locate one of the staff members she sets his page number on a pair of dials, and flips a switch. Four different numbers can be set into the encoder simultaneously, and the transmitter continues to broadcast each of them in turn until the number is switched off.

Subminiature Servo Motor. A high precision, subminiature unit, the *SM-58*, has been put on the market. With nominal dimensions of only ⅝ inch diameter by 1 inch length (plus shaft extension), this tiny motor weighs under 1 ounce. Its extreme small size, plus its valuable performance characteristics, make it widely applicable to servomechanisms, computers, indicating devices, missile control systems, aircraft control systems, and similar equipment. The motor is available with smooth or splined shafts. It is offered at a very moderate price. Component Sales, Ford Instrument Company, Division of Sperry Rand Corporation, 31-10 Thomson Ave., Long Island City 1, N. Y.

(Continued on page 79A)

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ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology
10 W. 35th St.
Chicago 16, Illinois

(Continued from page 78A)

TRADE LITERATURE

Trade Directory. The 1956-57 edition of the Radio-Electronics-Television Manufacturers Association (RETMA) Membership List and Trade Directory has been made available. It contains listings of all member companies, their chief executives, and their products. It also lists members of all divisions, committees, and sections, and personnel of all five RETMA departments. Supply of the directory is limited. Write to RETMA, Suite 800, Wyatt Building, 777 14th St., N.W., Washington 5, D. C.

Insulator Catalogue. Reported to be one of the most complete catalogs in the field, this brochure details general engineering data for purified porcelain insulators manufactured by Victor Insulator Division of ITE Circuit Breaker Company, Inc., Victor, N. Y. It includes the latest Edison Electric Institute and National Electrical Manufacturers Association standards and a presentation of Victor facilities for manufacture of porcelain to customer specifications. The first section of the catalog is devoted to a fully illustrated story of the company's plant, its research facilities, quality control systems, and manufacturing methods. Shown in catalog No. *56* are Victor's lines of pintypes, guy strains, spools, line posts, suspensions, switch and bus insulators, malleable forged steel and aluminum hardware, and a complete line of the new BIL indoor switch and bus supports. Copies are available to insulator buyers upon request.

Relay Facts File. An engineers' file folder containing complete information on Ebert Electronics Corporation's line of mercury plunger relays and related products has been made available. It includes load ratings and contact data, coil characteristics, diagrams and illustrations, and general information of particular interest to the engineer. The company's newly expanded line includes one-, two-, and three-pole relays in models for all loads up to 20, 35, and 60 amperes or 5 hp at 115 volts a-c and in various styles for every application. For the free fact file write to Ebert Electronics Corporation, 212-80Z Jamaica Ave., Queens Village 28, N. Y.

Power Transformer Instruction. A new transformer instruction bulletin has been issued by the Moloney Electric Company which should be of value to all those interested in power transformer maintenance and operation. The 80-page well-illustrated booklet covers, in detail, such subjects as installation, operation, component parts, maintenance, and inspection of power-type transformers in all ratings. This booklet, form *427-R-1*, may be obtained by request on company letterhead to Moloney Electric Company, Advertising Department, 5390 Bircher Blvd., St. Louis 20, Mo.

(Continued on page 82A)

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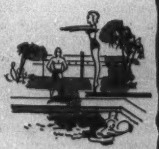

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- **Increased Personnel Safety**—entrance to the high-voltage compartments is impossible until the unit has been de-energized.
- **Easy Installation**—contactor may be rolled in or out of unit, and all connections are made from front.
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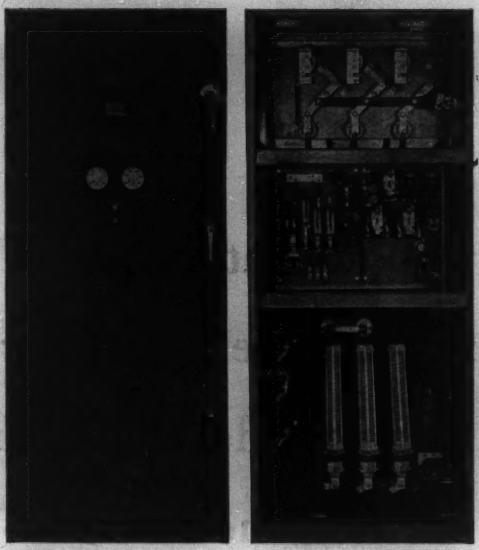
This new General Electric starter is designed to handle 2300 to 4600 volts for motors up to 3000 hp. Unit contains no power fuses; however, for interrupting capacities over 50,000 kva, fuses can be added.

Contact your G-E Apparatus Sales Office, or write Sect. 783-5, General Electric Co., Schenectady, N. Y. *Industry Control Department, Roanoke, Virginia.*

GENERAL ELECTRIC



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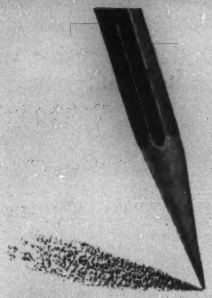

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(Continued from page 79A)

Trade Literature

Motor Bulletins. Three bulletins have been made available by Allis-Chalmers Manufacturing Company, 931 S. 70th St., Milwaukee, Wis. One describes the latest design features of the company's explosionproof motors in National Electrical Manufacturers Association (NEMA) rerated ratings and in nonrerated ratings. The other two bulletins describe, respectively, features of Allis-Chalmers open drip-proof motors, and totally enclosed, fan-cooled motors. For further information write to the company.

Precision Ball Bearings. A 64-page catalog on this subject is available to manufacturers of instruments, aircraft accessories, machine tools, and other precision mechanisms and components. Designed to give maximum information with minimum effort, it was prepared after a survey to determine the kind of material bearing users wanted and the form in which it would be most useful. In answer to requests for adequate indexing, the new catalog contains a dimensional index, a series index, and a visual guide to bearing types, characteristics and applications, as well as a separate index to selection and engineering data. For quick reference to standard bearings, pertinent information has been gathered into page spreads illustrated by cutaways and cross sections which contain dimensions, descriptions, specifications, and complete torque, static, and dynamic data in chart and table form. Selection and engineering data, some of which is presented for the first time, is organized according to users' requirements and keyed to bearing characteristics which fulfill the requirements. Available from the Barden Corporation, Danbury, Conn.

Booklet on Digital Techniques. The art of using digital techniques for testing, information handling, and control is the subject of an interesting booklet recently published by the Electronic Instruments Division, Burroughs Corporation, 1209 Vine St., Philadelphia 7, Pa. "Four Dimensions in Digital Design—Pulse Techniques for Modern Control," a 16-page booklet, should provide interesting reading for anyone involved in digital work. Yet it is basic enough to serve as an introduction to digital techniques for those who wish to learn more about how to use this art in their work. The booklet shows how digital techniques, as applied through Burroughs pulse control systems, provide increased measures of precision, control, and many other functions of research and manufacturing. An unusual series of die-cut pages illustrates graphically how a single combination of pulse control units can be rearranged in a number of ways to perform a variety of digital operations, including coding, simulation, and arithmetic problems. Free copies of the booklet are available by letterhead request to the manufacturer.

(Continued on page 83A)

(Continued from page 82A)

Trade Literature

Carbon Brushes and Commutator Maintenance. A booklet entitled "Carbon Brushes and Commutator Maintenance Team Up To Work for You" is available from the Westinghouse Electric Corporation. Written as a guide for the maintenance man in solving his commutation problems, the 27-page booklet is divided into three sections: maintenance requirements, factors affecting commutation, and carbon brush materials. The booklet also outlines accepted procedures for performing brush and commutator maintenance, and is illustrated with photographs and drawings. For a copy of booklet *B-6150-A*, write Westinghouse Electric Corporation, P. O. Box 2099, Pittsburgh 30, Pa.

Annunciator Systems. A 32-page catalog describing the complete line of standard, integrated annunciator systems for industry, manufactured by the Panalarm Division, Panellit, Inc., Skokie, Ill., is now available. The catalog organizes, in 14 sections, the complete story of the Panalarm annunciator system. The first three sections discuss company facilities, annunciator function and general features of Panalarm Annunciator Systems. Section Four illustrates typical industry applications. The next six sections present operating sequences, enclosures, mechanical specifications, technical data, and performance features of specific types of Panalarm Annunciator Systems. Available remote equipment and components, ordering information and engineering data are included in the remaining sections. Request catalog *100B* from Panalarm Division, Panellit, Inc., 7401 North Hamlin Ave., Skokie, Ill.

Publications Catalog. The 1956-57 edition of the American Management Association (AMA) Bookshelf, a complete catalog of the association's publications, has been distributed to the AMA's membership. It is also available on a complimentary basis to any interested manager writing on his organization stationery. Copies may be obtained by contacting Publication Service, American Management Association, 1515 Broadway, New York 36, N. Y.

Corrosion Chart. This useful reference chart covers the general corrosion action of various substances on copper and copper alloys and in some applications on iron, steel, and aluminum. The substances, which are arranged alphabetically, are divided into six sections: acids, chemicals, foodstuffs, gases, oils, and waters. The reference can be used as a source of information to aid the user in considering the use of copper and copper alloys. For the chart write: Wolvering Tube Division, Calumet & Hecla, Inc., General Sales Offices, 1850 Guardian Building, Detroit 26, Mich.

Principles of Transmission Line Relaying

This booklet (S-81) has been compiled by the AIEE Committee on Relays Subcommittee on Line Relay Protection. The objective is to present basic relaying philosophy rather than details and characteristics of specific relaying systems. Thus, to one who is not a relay specialist, the booklet is an opportunity to become familiar with the principles involved. The relay engineer will find presented a broad cross section of line relaying fundamentals that will be useful in his work, and engineers undertaking relay work will find these papers to be a valuable introduction and reference source.

More advanced forms of transmission line relaying, such as microwave relaying that are just coming into being, are not included in these papers, nor are simple straightforward applications considered. A concerted effort has been made to direct attention to the fundamental concepts and practices used in providing modern transmission line relay protection.

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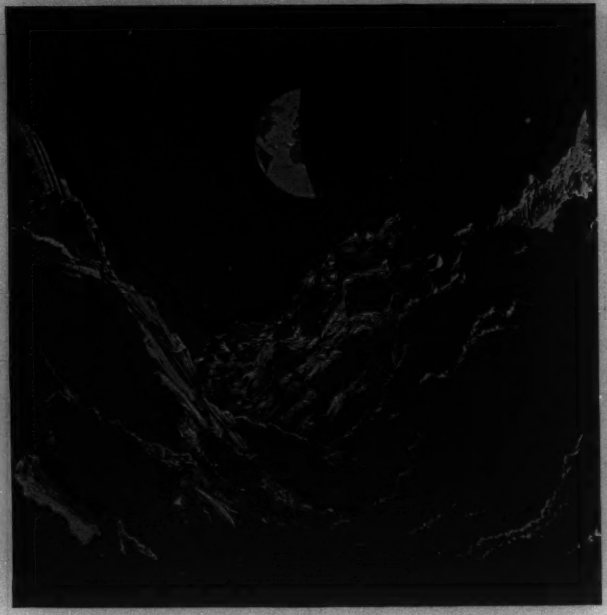

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TEACHING APPOINTMENTS—for January, 1957, or September, 1957, available at university-associated College of Engineering in Middle West. Appointments available in electrical power, electrical machinery, and electronics and communications. Salary and rank commensurate with experience and academic background. Small congenial faculty; suburban location near industrial area. Box 498.

ELECTRICAL ENGINEER—for development work with a small instrument manufacturer in Philadelphia, preferably with a theoretical and mathematical background in transient analysis and experience in high voltage phenomena as it applies to dielectrics. Box 501.

ASSISTANT OR ASSOCIATE PROFESSORS with Ph.D. or equivalent. Graduate and undergraduate courses in expanding department. Any field of E.E.; digital computers, nuclear power especially needed. With research, income $8,000-$11,000. High altitude, dry climate. Box 504.

INSTRUCTORS, RESEARCH ENGINEERS AND ASSISTANTS to work for D.Sc. degree at University of New Mexico. Large part-time graduate program assures variety of available courses. Housing plentiful. Chairman, EE Department, U.N.M., Albuquerque.

ASSOCIATE PROFESSOR ELECTRICAL ENGINEERING to teach graduate courses in transients, servomechanisms, vacuum tube circuits and electromagnetic theory as the need arises and to spend about one-half time on research and development work for contractor. M.S. required. Salary to $10,000 for 11 months. Write Box 511.

PROFESSOR OF ELECTRICAL ENGINEERING for one or two years assignment to India. Would be head of the Department of Electrical Engineering and in charge of research in the field of communications. M.S. or Ph.D. required. Very attractive salary and expense account for family. Write Box 512.

ELECTRONICS ENGINEERS. Significant and challenging programs in the fields of radar-aeronautical systems and electronics. The programs are categorized in a broad sense as follows: RADAR-AERONAUTICAL SYSTEMS—All-weather flight systems, radar control systems for airplanes and missiles, flight control computers, and specialized radar research. ELECTRONICS AND AUTOMATIC COMPUTERS—Communications and data processing systems, electronic computer techniques, flight simulators, with detailed electronic circuitry involved in these applications. Cornell Aeronautical Laboratory, Inc., 4467 Genesee Street, Buffalo 21, New York.

ENGINEERS—Openings in transformer design engineering and related apparatus, research and development in field of high voltage phenomena, studies of electrical properties of insulations, stress analysis and heat transfer. BS or MS degree in electrical or mechanical engineering. Experience up to five years useful, but not essential. Write Personnel Section, General Electric Company, Transformer Division, Pittsfield, Mass.

ENGINEERS: College positions. All sections of U.S., all fields of Engineering. Openings for B.S., M.S., and Ph.D.'s. Excellent salaries. Send pictures and qualifications to Cline Teachers Agency, Box 997, East Lansing, Michigan.